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THE READER:

INTENDED TO CONVEY

USEFUL FACTS, IN EARLY THEMES FOR CHILDREN.

BY

CUTHBERT W. JOHNSON, ESQ., F.R.S.,

AUTHOR OF "THE RURAL SPELLING-BOOK," ETC., ETC.

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PREFACE.

THE same objects which the author of this little work endeavoured to promote in "The Rural Spelling Book"* he has steadily aimed to pursue in the following pages; viz., to inculcate useful, every-day principles and facts, when teaching even very small words and sentences, keeping constantly in view the works of God in the phenomena of daily life, and of the animal and vegetable creation. The various notes dispersed through the following pages are chiefly intended for the use of the teachers of youth. The kindness with which they have received his former little efforts assures the author that they will readily aid him in so good a cause with valuable suggestions for its improvement.

14, *Gray's Inn Square.*

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* Just Published, price 1s. 6d., bound in Cloth, the New Edition of
THE ENGLISH RURAL SPELLING-BOOK,
With Easy and Progressive Lessons; intended as an Introduction to the Spelling and Reading of the English Language, and to the First Principles of the Practical and Scientific Cultivation of the Soil.
BY CUTHBERT W. JOHNSON, ESQ., F.R.S.

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THE READER.

THE DUTIES OF LIFE.

OBEDIENCE TO GOD'S LAWS.

We cannot fulfil the duties of life without a constant reference to the will of God as revealed to us in the Bible. We are there taught that the duties of life are to obey His commands, to fear to do any wicked thing in His sight (and God sees us always, as well in the darkness as in the light); and to do to our neighbour as we would he should do to us. Good children, therefore, will not do any wicked thing, for they know God's eye is upon them; and they will not do any unkind or cruel act to any living creature, either man or beast, because they know they would not like any unkind act done to themselves.

The danger and ingratitude of disobeying the commands of our Heavenly Father is known to every virtuous and well-taught child, who will remember that by such conduct he is certain to bring down God's displeasure upon him, and that he will not only lose the happiness which always attends, even in this life, an exact obedience to the will of God; but that he is certain to reap hereafter the fruits of his disobedient conduct in that place provided by God for all wicked spirits and bad people.

Our ingratitude, by disobeying His commands, every child must feel, who thinks upon the blessings, both on earth and in heaven, which are promised to those who obey God's will. The joys of heaven, we are told, no eye hath seen and no tongue can tell. But the blessings given us here on earth we all can feel and all can understand. We cannot sit by our warm fireside, or walk abroad in the fields and meadows, without feeling the kindness and benevolence of our Father in heaven, who has created so many comforts for us. God, when he made the dreary season of winter, gave us fire and fuel to ward off its rigours; and when He made the beautiful summer season, He gave us seeds and plants to put into the earth, and He waters them from the clouds, and causes them to grow and to ripen for our food. Yet how few of us think of these things! how seldom do we reflect upon the condition we should be in without the blessings of fire and food! But God has not seen fit to impart these blessings to all alike: to some of us He has given far more than to others. Let those good and grateful children, therefore, who sit by their warm fireside, with every comfort round them, or when they eat a good and plentiful meal, remember that there are very, very many good, but poor children, who have not these blessings; let them do as they would be done by, and let them give a portion of their store to those who stand in need of help.

Then, again, in our walks in the fields, we should reflect that, if God had not regarded our happiness, we should not have a sweet balmy air to breathe—enjoyed the odour of the violet and the rose—the music of the birds—the delicious sweetness of ripe fruits—the brilliant colouring of thousands of flowers of every hue, to delight our eyes. Let the good child think of these things; and, if he does so, he will on all occasions see reason to obey the commands, and bless and praise his good Father in heaven, from whom all blessings flow.*

OBEDIENCE TO PARENTS AND TEACHERS.

Those children who wish to obey the commands of God, will ever be ready and anxious to obey the commands of their parents and teachers. By so doing they not only obey the written word of God, as revealed to us in the Holy Bible, but they by this means secure to themselves the blessings which he has promised to those who obey his commands. For it is foolish and vain to hope for any blessing, without an exact attention to the directions and instructions of those who love us, and who know by long experience what is for our good—what we ought to do, and think, and learn. And when they engage learned, good, and wise teachers for us, who by a long course of study have qualified themselves to teach us all that will tend to our temporal and eternal welfare, is it not the very greatest folly and wickedness to throw away the advantages we are thus offered? And does not every little child who disregards his teacher's kind instruction, and, by being idle and careless, ungratefully throws away all the expense of his education, show, not only that he is a very foolish, but a very wicked child?*

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* The great Paley, on more than one occasion, dwelt with great eloquence upon the goodness and benevolence of God. "When God created the human species," he unanswerably remarks, "either he wished their happiness, or he wished their misery, or he was indifferent and unconcerned about either. If he had wished our misery, he might have made sure of his purpose, by forming our senses to be so many sores and pains to us, as they are now instruments of gratification and enjoyment; or by placing us amid objects so ill suited to our perceptions, as to have continually offended us, instead of ministering to our refreshment and delight. He might have made, for example, every thing we tasted bitter, everything we saw loathsome, everything we touched a sting, every smell a stench, and every sound a discord. If he had been indifferent about our happiness or misery, we must impute to our good fortune (as all design by this supposition is excluded) both the capacity of our senses to receive pleasure, and the supply of external objects fitted to produce it. But either of these, and still more both of them, being too much to refer to accident, nothing remains but the first supposition, that God, when he created the human species, wished their happiness, and made for them the provision he has made with that view and for that purpose."—*Nat. Theology*, chap. 26.

OBEDIENCE TO THE LAWS OF THE LAND.

It will be well for the little reader to recollect that he who wishes to employ his time as well and as happily as he ought, cannot do so without a firm and cheerful obedience to the laws of the land.†

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* The duty of children to parents was deemed worthy of a place in the Ten Commandments. "Honour thy father and thy mother, that thy days may be long upon the land which the Lord thy God giveth thee" (Exodus xx. 12). And again, St. Paul, in his Epistle to the Ephesians, says (chap. vi. ver. 1): "Children, obey your parents in the Lord; for this is right. Honour thy father and mother, which is the first commandment with promise. That it may be well with thee, and thou mayest live long on the earth."

† "What," as the Rev. Dr. Trower justly remarks, "would be the condition of society if every man did that which is right in his own sight? or rather how impossible would it be for society to exist!" In proportion as law is honoured and obeyed, the good are protected and the wicked are restrained, and the amount of human happiness is increased. The very worst law and the most tyrannical government is far better than lawlessness. How excellent are those words of Hooker, at the end of the first Book of his Ecclesiastical Polity: "Of law there can be no less acknowledged than that her seat is the bosom of God, her voice the harmony of the world. All things in heaven and earth do her homage; the very least as feeling her care, and the greatest as not exempted from her power; both angels and men and creatures, of what condition soever, though each in different sort and manner, yet all with uniform consent, admiring her as the mother of their peace and joy."

He must always regard as the enemy of his country every one who breaks those laws, or does anything that impedes their execution. To this end he will avoid the society of those who speak ill of our good Queen, or of either of the Houses of Parliament, or break the laws which they enact. The child must be early taught that there are certain great and noble principles in the laws of England, which have been handed down to us by the great, the wise, and the good of former ages, which great laws he must ever firmly regard as an inheritance far above all price, and which he must be ready at all times, when he approaches to years of manhood, to defend. He must, in fact, early learn that his country must be regarded by him as a land whose laws and liberties he ought to be proud to uphold, at any personal sacrifice, against all those who would in any way injure the one, or abridge the enjoyment of the other. The little reader will soon learn, when he is able to read larger books than this, how many good and wise and brave kings, legislators, and patriots, have in former days sacrificed their time, their fortunes, and their lives, in the promotion, the improvement, and the defence, of these noble laws of the land of England; laws, whose merits generations long past have experienced, and to which time each day bears witness. The little reader will, as he grows older, feel all these things; he will then be ready to guard them from injury, and to hand them down unimpaired to those who will have the enjoyment of them when he is dead and gone.

OBSERVANCE OF OLD CUSTOMS AND RIGHTS.

There are certain old customs, and rules, which when well observed, tend very much to the quiet and comfort of our way through life. The good and well-taught child, therefore, will recollect these with much care, and consider as the real enemies of the comfort, and of the duties of life, all those who disregard or abuse these good old customs. These are many in number, yet very easy to be understood, and very readily observed by every one. We cannot walk out without noticing some of them. They are rules which enable us to distinguish very easily the well taught, from the stupid and ignorant. Even in a crowded thoroughfare, one well understood rule is, that in meeting a person on the footpath, you leave him on your left side; that is, the *right* side of the pathway as you move along is *your side*. A contrary rule prevails in the *roadway*, for there the *left* side is your place, either in driving or in riding: and if, through any neglect of this rule, you are the cause of damage to any other passenger, the law will compel you to repair the injury your neglect has caused. But if, by forgetting this rule on the pathway, you do not cause any damage to the passenger, you still act a wrong part; you cause confusion and the loss of the time of others (and time, remember, is what life is made of), and you diminish the pleasure and benefit which other persons take in their walk; you thus deprive them of what is not yours; you do not intend to rob any one in particular, but remember you steal from the community at large. And again, the law of England, for certain good and wise reasons allows the well conducted wayfaring traveller to pass unmolested through certain thoroughfares, and even in public footpaths over the fields of others. This privilege is a most valuable one, both to the poor and to the rich. It enables the poor foot passenger to reach his work by a nearer and a pleasanter path than by the road; and it affords to the richer classes the most pleasant walks, health, and freedom from dust: to all persons, in fact, it gives the enjoyment of hedge-rows full of wild flowers, the songs of birds, the closer inspection of the rural operations, and fragrant crops of the farmer and the gardener. This is a privilege which should never be used in such a way as to render it injurious to the owners of the land through which these public paths extend. Every child who leaves the path, and walks on the adjoining crops, injures the farmer by every step he thus takes. It is no excuse that by so doing "he hardly injures a blade of grass." Such a child should be early taught that a robbery is not excused by its being very small; that he has no more right to destroy a blade of grass belonging to another than he has to destroy the grass on all the field; the same remark applies to taking a turnip, or cutting a stick out of the hedge. The robbery is the same; there is no difference in the principle. If there is "no harm in taking a turnip," then the whole crop may be carried away, if any great number of persons pass through a field, and each takes only a single turnip. Such a defence may be used by the very ignorant, because ill-taught, and we can only pity him as a silly and wicked child; but we all know that the judge, before whom such a child is tried, will not listen for one moment to such a defence as that "it was only a turnip, or only a stick that was taken from beside the footpath." Let the good child then carefully remember, in walking across the land of others, that this is a privilege which he must on all occasions so exercise as not to injure the property of the owner of the land in the slightest degree; for if he does, he not only commits a vile robbery upon the farmer, but he injures the community at large by rendering the owners of the land inclined to adopt every means in their power to abridge the freedom of such paths, and, by one means or other, to exclude the public from their use. It is in the same good spirit that many other good customs should be regarded; many other inroads upon the true enjoyment of life avoided, that we need not include in this lesson.

THE TRUE HAPPINESS OF LIFE.

THE ENJOYMENTS OF A GOOD CONSCIENCE.—THE AVOIDANCE OF SIN.

Youth is the period in which the great foundation of the true enjoyment of life is laid; then is the time to acquire those good principles and habits on which that good foundation is formed. This must rest on the religion of Jesus Christ, who came into the world to teach peace and good-will to all mankind. It may be spread out into various and many branches—in morality, on the love of God; but all centres in one point—obedience to his revealed will. So long as this is strictly regarded by the young child, so long will he enjoy the happiness of a good conscience.

The happiness of all young creatures shows the goodness of God.* As, then, the great Creator of the universe thus provides for our happiness, until our own follies and wickedness destroy those happy feelings which the infant enjoys, let my young readers resolve to keep and extend that happiness by pursuing all those calm enjoyments which a well-spent life of industry and obedience to God's laws are certain sooner or later to bring. To this end let the young carefully avoid, on the one hand, idleness, as the sure road to wickedness and misery; and on the other, let them as carefully remember, in even their most industrious moments of mental and bodily exertion, that, without God's blessing, the utmost efforts of childhood and of manhood are in vain. And, as it is well remarked in the story of the Two Shoemakers (a remark which may be with advantage treasured up by children of all ages), one good end of our bringing religious thoughts into our business is, to put us in mind not to undertake more business than we can carry on consistently with our religion. I shall never commend that man's diligence, though perhaps it is often commended by the world, who is not diligent about the salvation of his soul. We are as much forbidden to be overcharged with the *cares* of life as with its *pleasures*. I only wish you to be convinced that a discreet Christian may be wise for both worlds; that

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* Of this a celebrated author has remarked, "The young of all animals appear to me to receive pleasure simply from the exercise of their limbs and bodily faculties, without reference to any end to be attained or any use to be answered by the exertion. A child, *without* knowing anything of the use of language, is in a high de-

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gree delighted with being able to speak. Its incessant repetition of a few articulate sounds, or perhaps of the single word which it has learned to pronounce, proves this point clearly. Nor is it less pleased with its first successful endeavours to walk, or rather to run (which precedes walking), although entirely ignorant of the importance of the attainment to its future life, and even without applying it to any present purpose. A child is delighted with speaking without having anything to say, and with walking without knowing where to go. And prior to both these, I am disposed to believe that the waking hours of infancy are agreeably taken up with the exercise of vision, or perhaps, more properly speaking, with *learning to see*."

he may employ his hands without entangling his soul, and labour for the meat which perisheth without neglecting that which endureth unto eternal life; that he may be prudent for time, while he is wise for eternity.

THE OUTWARD PURITY OF OUR PERSONS.

The care of our persons is not only a duty, but a pleasure: it is one equally enforced by the dictates of prudence, the laws of decency, and the commands of God. These are, however, especially in the case of the poorer classes of the community, too often disregarded. The results of this neglect soon show themselves, not only in a disregard of moral and religious duties (since there is a certain and intimate connexion between the inward purity of the mind and the outward purity of the person), but in the utter neglect of all comfort, and the certain origin of disease.

The insensible perspiration, which is constantly escaping from the skin of all healthy persons, is essential to their health. When this is checked, many diseases arise. The cleanliness of the skin, therefore, is of the highest importance to health; but this wholesome state of the skin is deranged as soon as its pores are closed up by dirt. This secretion, it is observed by an eminent physician,* by being allowed to remain on the skin itself, or on the clothes which cover it, becomes not only offensive, but highly irritating, and productive of a great variety of loathsome and distressing eruptions. I do not hesitate to declare, from repeated and careful observation, that the habits of too many of the poor, promote and foster various errors of negligence and omission, which not only render poverty more distressing and degrading, but which also tend to perpetuate it, and at the same time render it more exposed to the attacks and ravages of disease. The remedy for these evils consists in the more regular application of cold—or, still better, warm—water to the surface of the body. This cheap and universal fluid is within the reach of all persons; and there is no doubt that, by its regular and constant application, the best results to the true pleasures of life are certain to arise. The body is rendered more healthy, the spirits more elastic, the whole frame of our minds improved. And if, when we are thus applying water to the surface of our bodies, the application is further periodically extended to the floors and walls of our rooms, still greater advantages always arise in still more rapidly promoting these pleasures, especially if, in the periodical application of the water to the walls and ceilings of our rooms, we took the pains to add to it a portion of lime or whitening; for by this means the general cleanliness of our persons and clothes is materially promoted, diseases still more effectually banished, and, from the whiteness thus imparted to our rooms, more light is given to our dwellings. The advantages of light I shall, in the course of this little work, endeavour to show, add to the health of the body, and, consequently, to the true enjoyment of life.

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* **Dr. T. Hodgkin on Health, p. 25.**

HOUSEHOLD CLEANLINESS.

It is idle to expect that those who neglect the cleanliness of their houses can be either healthy in body or in mind. Dirt is ever the forerunner of disease; and the dirty, the drunkard, and the dissolute are sworn friends. Those whose minds are depraved always hate cleanliness. The keepers of the English prisons, who have to cleanse the persons of all the rogues and vagabonds who are committed to their care, all agree in testifying that the washing which these have to undergo, is regarded by such persons as the greatest punishment of all that they experience during their confinement. They are willing to part with their liberty and anything else rather than the dirt in which they are encrusted. Such people are commonly found living in dark and filthy places; and darkness not only tends to increase the difficulty of removing dirt, but the want of light causes persons who live without it to be unhealthy. " The more dark corners you have in dwelling-houses," observed, on a recent occasion, an eminent surgeon, " the greater is the amount of dirt and filth. I consider the influence of light the most important during childhood, because it directly influences the physical development. The amount of disease," he added, " in light rooms, as compared with that in dark rooms, is always much less."*

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* The evidence on the bad effect of dark places on health is very strong. " During a practice of thirty years in a densely-populated neighbourhood," said Mr. N. B. Ward (1 Sanatory Report, vol. i., p. 41), " my attention has been repeatedly drawn to the influence of light, not only as a most efficient means of preventing disease, but likewise as tending materially to render disease milder where it occurs, and more amenable to medical and other treatment. Dupuytren (I think) relates the case of a lady whose maladies had baffled the skill of the most eminent practitioners. The lady resided in a dark room (into which the sun never shone), in one of the narrow streets of Paris. After a careful examination, Dupuytren was led to refer her complaints to the absence of light, and recommended her removal to a more cheerful situation. This change was followed by the most beneficial results: all her complaints vanished. Sir James Wylie has given a remarkable in-

The increase of household cleanliness always advances the health of the inmates. There are several well-known instances of this result. The health of our brave British sailors has in this way been much improved. The ravages of the scurvy were very greatly reduced as soon as greater cleanliness and better ventilation were accomplished in our ships. As soon as our great towns became more cleanly the plague ceased to visit them; and if fevers do occasionally visit such crowded places, the attack is almost always commenced in the dirtiest streets and in the most ill-cleansed localities.

Let the pupil, then, carefully remember that it will not be possible to enjoy a healthy frame of body or of mind without a patient and strict regard to personal and household cleanliness. The experience of all persons and of all nations will tell him this. Nations in a state of barbarism are ever negligent of their persons and their dwellings. The first symptom of their improving condition is pretty certain to consist in an increased attention to cleanliness.

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stance of the influence of light. He states that the cases of disease on the dark side of an extensive barrack, at St. Petersburg, have been uniformly, for many years, in the proportion of three to one to those on the side exposed to a strong light. The experiments of Dr. Edwards are conclusive. He has shown that if tadpoles are nourished with proper food, and exposed to the constantly-renewed contact of water (so that their beneficial respiration may be maintained), but are entirely deprived of light, their growth continues, but their metamorphosis into the condition of air-breathing animals is arrested, and they remain in the form of large tadpoles. Dr. Edwards also observes that persons who live in caves and cellars, or in very dark and narrow streets, are apt to produce deformed children, and that men who work in mines are liable to disease and deformity beyond what the simple closeness of the air would be likely to produce."

THE AIR WE BREATHE.

We cannot value too highly the free use of good air. In close rooms air becomes very speedily too highly heated and unfit for breathing. It is not only injured by the breathing of animals, but by the burning of candles, by fires, by the presence of bad smells, and from various other causes. If our rooms could be made as air-tight as by our utmost efforts we sometimes endeavour to make them, the vital air, or portion of common air fit for breathing, would soon be consumed, and death by suffocation must result. But as our rooms are not air-tight, as air *will* find its way into them in spite of our utmost efforts, it is seldom that we hear of any person being suffocated from being confined in a close room. Yet instances have occurred in many very memorable cases, as in persons confined in mines, or in diving bells, whose machinery has become defective. But although we are not met at every turn by such cases of rapid death from impure air, yet the slow, equally sure, and fatal result of breathing an impure air, would hardly, with common attention, escape our notice. If we did but think of these things, we should be less negligent in the regulation of the windows and doors of our dwellings.*

"If then," remarks an eminent English physician,† "we consider how large a portion of the divine moral law relates to our duty to our neighbours, and how much filthy habits are injurious to them, as well as to ourselves if we unhappily adopt them, we surely need feel no hesitation in admitting the truth of the remark, that cleanliness is next to godliness." And further, we may well remember with advantage, that it is difficult long to preserve that degree of cleanliness or healthiness on which depends so much of the true happiness of life, if we from idleness or carelessness breathe constantly an atmosphere already breathed by other persons, or made unwholesome with the noxious smells and gases of putrefying animal and vegetable remains.*

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* It might increase our care to preserve the purity of the air in which we live, if we remembered the large and constant supply which every person requires to preserve life. It has been found that every person breathes on an average 666 cubic feet of air during 24 hours. That is, a person confined in an air-tight room 10 feet square, and nearly 7 feet high, would, in about 24 hours, consume the whole air which it contained.

† Dr. Hodgkin, p. 17.

GOOD WATER

How much good do we all derive from an abundant supply of wholesome water! Mankind have, in all ages, been aware of its value. The founders of the chief towns and cities of antiquity, paid the greatest attention to this great necessity of life. They well knew its value, for without water neither cleanliness or health, or even life, could be preserved. They were careful, therefore, to place their towns either on the banks of copious rivers, near to abundant springs; or if they did place them at a distance from these, the remains of their gigantic aqueducts and tanks tell the passing traveller the pains which bygone generations bestowed in the guiding the water of distant springs near to their dwellings, and in the storing of rain water. In our times, we seem to pay more attention to the quantity of the water with which we are supplied than to its purity. What we are so publicly careless of, we also privately disregard. We are too often at best content with the use of water obtained from wells, water which is ever of various degrees of *hardness*, and is at once less wholesome, and much less economical than *soft* water. Every washerwoman is aware of this: every brewer of beer, every maker of tea, can attest the fact, that the softer the water the stronger is the beverage produced. But the evil does not always end here: in some places a very bad water is used—that from stagnant ponds, or wells fed only with marsh or bog water. The very taste of such water betrays its origin. It has a peculiar flavour, indicating the presence of various gases, which even boiling it does not entirely remove. It is around the dwellings of the consumers of such water that intermittent fevers, or other epidemic disorders, are pretty certain to be found lurking. It is with such water that the worst ague districts of England are supplied. The remedy is easy; in most places deeper wells would hardly fail to reach purer springs, whose waters at least are free from the various impurities of stagnant pools. In any case, however, rain-water may be had in sufficient quantities for the domestic use of the inhabitants of every house. Rain-water, too, as it falls upon the roof of a house, is the purest and best of all waters. It is the best and most copious in its amount from a slated roof, for slates are not only cleaner than either thatch or tiles, but they do not *absorb* any of the rain-water as thatch and tiles do. The purity of rain-water is readily insured by causing it to flow in its way to the tank (which is generally made too small) through a little coarse white sand, which strains out the soot, leaves, and other matters which would otherwise, by putrefying in the water, render it impure, and consequently not fit for drinking or for culinary purposes.*

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* The effect of the long-continued breathing of air thus made impure by the breathing of other persons, is speedily shown by the unhealthy appearance, the lowness of spirits, the loss of appetite, and state of indigestion of those thus situated. Still more decided are the ill-effects of breathing air contaminated by the presence of various gases emitted during the putrefaction of animal and vegetable substances. Of all these pernicious gases the sulphuretted hydrogen is perhaps the most noxious. It is emitted in almost all badly drained and foul places. Its presence may be often indicated by the silver in a house becoming tarnished, much in the same way as when a silver spoon is used with an egg: in fact, the intolerable smell emitted from a rotten egg is owing to this gas abounding in it. Its presence is readily detected in stagnant drains, cesspools, and sewers; and many fatal accidents have in consequence arisen to the workmen employed in such places. It is, even when considerably diluted with the common atmospheric air, exceedingly pernicious to those who breathe it. Small birds die in such an atmosphere immediately. The bird fanciers of London cannot keep them near those places where this gas is emitted from ill-drained localities. It is but a few years since that a lady lost her life in Paris by going into a bath that had been artificially charged with this gas.

Let the young reader carefully treasure up in his mind these facts: let him never forget the great truth, that of all the necessaries of life and of good health, nothing is more essential than good water; and that, if that is not to be had in a tolerably pure state, all other efforts to promote health and comfort are vain.

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* I will here repeat what I have in another place (*Rural Spelling Book*, p. 42) had occasion to remark upon this very important head, since the extent and quality of the supply in England of rain-water are much too rarely considered. It is well known that some waters are called "hard," and are unfitted for the purposes of washing and brewing. This is owing to such waters holding, dissolved in them, either chalk or gypsum (carbonate of lime, and sulphate of lime), either of which, by decomposing, renders more expensive the use of the soap, and materially retards the extraction of the saccharine matter from malt. Rain water, from the total absence of these two substances, is the "softest" and best of all water for washing and brewing; and if proper care is taken in its collection and storing in tanks, no family need be without an abundant supply of it; for it has been determined, that sufficient rain falls on every house in England for the use of its inhabitants. Although this varies in amount in different districts, yet the average annual depth which falls in England is about 24 inches, or more than 12 gallons upon every square foot of the roof (a gallon contains 277.274 inches; so that, supposing the roof to be 15 feet square only, more than 2,800 gallons of water, or about 8 gallons per day, fall upon it in rain every year.

THE COMFORTS OF KNOWLEDGE.

The increase of comfort ever follows the increase of knowledge. This has been the case in all ages. And in reading the history of our own beloved country, we find this great truth to be fully proved. Those, who are the best instructed amongst the poorer classes, we shall find, are almost always those who have the best washed houses and persons, the best flowers, the cleanest clothes, and the most wholesome food. Knowledge generally banishes dirt, drunkenness and misery. Knowledge is an enemy to close, badly aired rooms; to stagnant pools near dwellings, which bring disease. Disease delights in dirt; in fact, it is caused by filth; it avoids the cleanly. Let us see what privations former generations of Englishmen suffered from want of knowledge. The early inhabitants of England, it is pretty certain, lived either in caves, or in houses built of the branches of trees, thatched with reeds, or covered with the skins of beasts. They had no windows. Glass was only a later comfort procured by advancing knowledge. Chimnies, too, were not used. Holes in the roofs of the buildings let out the smoke of their fires, whilst it let in the rain and wind at the same time. The food they lived upon, the chase supplied: when that failed them, they lived upon the bark of trees. The cultivation of corn was a comparatively late introduction. It is supposed that it was about 640 years after the birth of our Lord and

Saviour before wheat was grown in England. It was in those times that dreadful famines used to destroy so many persons. The people then were very ignorant: they loved idleness; and we all know that ignorance, idleness, and poverty always go hand in hand together.

THE ORIGIN OF COMFORT.

We learn from the best of all books, our Bible, that man was first created and placed by God in a garden. This garden, or Paradise, was placed far away from our country, in a warm and delightful climate. Little labour was needed to gather its fruits. Few clothes were required to protect the first inhabitants of the earth from the effects of the climate. But as mankind began to increase in numbers, they soon, when banished from Paradise, began to spread themselves over the face of the earth. They began to dwell more and more to the north of the land of Ethiopia, where Paradise was placed. And as they advanced to northern countries, they found a colder climate, a more barren soil. In this progressive march of increasing numbers, they in time arrived at the sea, and at length at that narrow portion of it (between Dover and Calais) which separates the continent or mainland from our own island. Viewing its noble white chalk cliffs from the shores of France, they called it Albion—a name by which it was long known to the then somewhat civilised and partially inhabited world. It was thence, we may rest assured, that the early inhabitants of this country came. These early settlers, there is little doubt, lived by the produce of the chase, or by fishing. They were obliged to seek out or construct their own caves or huts for dwellings; made their own clothes out of the skins of wild animals; had no laws to regulate their conduct; were, in fact, rude Barbarians. These had neither comforts nor security for either their property or their persons. They slowly, however, began to improve in knowledge, and *comfort* then began to be first known in England. This origin of knowledge, and consequently of comfort, commenced from the increase of the number of the inhabitants rendering it necessary for men to live more closely together, and in more fixed habitations; to elect a governor or chief; to have some general binding rules or laws for the protection of their property and their persons. This course of events originated the first generally recognised rights of property; it was a natural result of the first glimpses of knowledge: Every one soon saw that no man would build a house, or make even a fishing hook, if a stronger man could, without punishment, take by force the result of his neighbour's labour. No one would, unprotected, work; and consequently, without the right of property, all inducement for labour was at an end; every one was idle; and, as a natural consequence, when the game was scarce, or the seasons unfavourable, then arose general starvation and pestilence. Hence soon came the early establishment by common consent of wise laws, establishing and regulating the rights of persons and the rights of property. These were at first expounded by the heads or chiefs of the tribe; and from a very early period of England's history, by a rude yet simple form of trial by the neighbours, the origin of our modern juries. Let us not fail to note the good results which followed *this only* foundation of all comfort, when men first began to live under a law which respected the rights of property and of persons. Knowledge, too, then soon increased, for it met its reward. The march of comfort then first commenced, and, as a natural consequence, the progress of knowledge was again accelerated.

THE PROGRESS OF KNOWLEDGE AND COMFORT.

HOUSES.

We have already seen that the first inhabitants of England lived in caves, or in huts. The first improvement upon these could only commence when they learnt to make tools of iron. When increased knowledge had enabled them to do this, comfort soon began. They then were able to construct dwelling-places of clay, or wood, or stone. They then exchanged the damp and dark caves, in which they first sheltered themselves, for drier, lighter, and more wholesome dwellings. These were, it is true, at first covered with branches of trees, and afterwards with reeds; they were without any windows or chimnies, but they were gradually made more comfortable as knowledge increased. But this progress was much more slow than is generally understood. Wood was long the only material employed. 670 years elapsed from the birth of our Saviour before buildings of stone were erected in England. Another long period of nearly 200 years elapsed before (about A.D. 886) houses were built of bricks; and it was not till about the year 1236 that they began to discard thatch from their roofs for tiles. As for chimnies, they were not generally made in English houses till about the year 1300. Glass windows were beginning to be introduced into houses about the year 1180; but window-glass was not made in England until the year 1557. The houses were at first warmed by fires of wood. Coals were not employed till about the year 1280, and they only became commonly used in London about the year 1400. If dwelling-houses were at first warmed only after this rude fashion, they were as poorly lighted. Light was procured by burning splints of wood repeatedly dipped in melted fat. Tallow candles were only beginning to be used in the year 1290. Wax candles were then entirely unknown. As for our present gas lights, they were not invented till centuries after, and they were only generally employed for lighting shops and streets in 1814. In whichever way, therefore, we direct our attention around the houses in which we dwell, we perceive abundant proofs of the advantages of knowledge; and these must assure us that knowledge is the parent of household comfort.

FOOD.

The first inhabitants of our island chiefly lived, there is little doubt, upon uncooked food. If they cooked the portion of their food which the chase yielded, roasting or baking would be the easiest and rudest mode. Boiling would of necessity require vessels of metal or of earthenware. These were means of comfort which required the artisan, and he never appears in any uncivilized country; he is one of the offsprings of knowledge, security, and comfort. The artisan follows the steps of civilization: amongst rude nations every one is his own tailor and builder. Man thus placed does everything for himself; and, as a natural consequence, every domestic requirement is imperfectly performed. Untanned skins form his clothes; shoes are unknown; the head and the feet are equally uncovered. Flesh of animals, we perceive, must have been the chief food of the first inhabitants of England; since all those many vegetable productions, which now add so much to our health and comfort, owed their first introduction to the gradually increasing knowledge of succeeding generations. The blackberry, the sloe, and the crab, are the only plants which grow naturally and ripen their fruit in England. We shall find that it was only about the year 640 that even wheat was first cultivated in England. It is pretty certain that, hardly more than three centuries since, the very commonest of our garden vegetables were unknown. Cabbages were not cultivated in England until about the year 1515. Apple and plum trees did not arrive for some years afterwards. Gooseberries and currants not till the year 1548, and potatoes only in 1563. As for sugar, it was only first grown in the West Indies about the year 1510. Tea was unknown in England until about 1666. It need, then, hardly surprise us that, with so limited a supply of vegetables, the ill effects of a too abundant diet of animal food then generally displayed themselves in scurvies, leprosies, and other diseases of a similar origin. Education diffused itself very slowly down to the reign of Elizabeth, queen of England. Knowledge, therefore, was still confined to the few; and, as a natural consequence, comfort was as yet equally little known.

CLOTHES AND FURNITURE.

In the first period of the occupation of England by *mankind*, there is no doubt that, as the flesh of animals served for food, so their skins served for clothes. They had no woollen fabrics to use for such a purpose; they had neither manufactures of their own, or money, or other articles of barter, to exchange for the clothing materials made by the nations of the continent, who were more advanced in knowledge and comfort. Woollen clothes (first made in this country in 1191) and those of flax were the early products of advancing knowledge and civilization. Those of silk were not made in England till about the year 1604. Hats were not made in this country until about the year 1510. Shoes were not produced, of the present fashion, until 1633. As to furniture, the early inhabitants of England employed leaves and dried grass for beds; logs of wood, or stones, served the office of chairs and tables; the earth was their floor. It was only by gradual degrees that benches and other raised seats were used. The floor was at length garnished with rushes and straw, mixed with sweet-scented hay or flowers. Another long interval elapsed before, about 1750, carpets were first made in England. The beds on which our ancestors slept were often made of straw: even the kings' beds were made of it to the year 1234. Linen was first made in England in 1253. English blankets were not made before about 1340. Calico was not manufactured in England till 1772. If my little reader will but think of these things—will but remember that his dwelling, its furniture, his clothes, and his food, show how the increase of knowledge has gradually produced comfort, and how great is the advance which these two (knowledge and comfort) are continually making together, he will not fail to be deeply impressed with the advantages which knowledge (the fruit of study) has produced in even his creature comforts; that is, in a better dwelling, more wholesome food, warmer clothes, and more convenient furniture.

HORSES.

The rude inhabitants of those countries where the horse is a native have but the imperfect use of these noble animals. They are generally ill shaped and coarse looking, are badly fed, and worse groomed. As beasts of burthen, they were at first rode without saddles. English horses were not even shod with iron till about the year 531. When used for the purposes of draught, there is no doubt that at first they were made to draw with very rude harness. When plough harness was first introduced, it was made of withes, or twisted sallows. Harness of coarse leather thongs, then of cordage, and lastly of iron chains, were later improvements. The simple contrivance of buckles was not invented till about 1680. The horse being fed, in those early times, only upon grass and hay, would naturally be capable of little exertion: to feed them with corn required another great increase of knowledge. In rude nations, the owners of horses very little understand the nature of their diseases. In the time of our forefathers, they often deemed a sick horse to be bewitched, and attempted his cure by unmeaning charms, by potions equally useless, or by operations as cruel as needless. When we smile at the childish simplicity thus evinced by our rude forefathers, let us not omit the very useful inquiry, if our present management of horses has quite lost all its barbarism. If, during such a search, we find that we still are in the habit of often taking the energies of those noble animals far beyond their power, till they become diseased and unsound; if we still neglect to feed them—confine them in unwholesome, ill-ventilated stables, and then proceed to cure the diseases we have caused them, by useless and painful operations; if we find this to be the case, may we not then draw the very reasonable and profitable conclusion, that knowledge has yet a large field left to it for the improved comfort of our horses?

CATTLE.

Our earliest notices of the cattle which were at first bred in England lead us to conclude that they were a very coarse and profitless breed. They had, it would seem, large bones, great heads, and would fatten but by slow degrees; such as they were, however, the husbandman kept them with difficulty and with but little profit to himself, except in the choicest situations, where the grass grew luxuriantly, and where the meadows were not burnt up by the heat of summer. He had, in general, no means of feeding them, except on grass or hay; his oxen, therefore, were chiefly fattened during the warm seasons of the year. He was in the habit of killing off his fat animals as the winter approached, and salting their flesh; he lived on salt meat and salt fish during a great portion of the year; and this, as a natural consequence, caused scurvy and other diseases of a like kind to prevail. Those cattle which he did keep during the winter were with great difficulty preserved, especially during hard seasons. They had no resource when their stock of hay was exhausted; they were constantly exposed to the attacks of the robber and the wolf; and, from bad keep, they were peculiarly subject to the attacks of various fatal diseases. Here, again, knowledge and comfort have gone hand in hand together, for a long series of years, with increasing advantage to both the cattle and their owners. Better and well-administered laws have nearly banished the cattle robber from this country, and wolves have long since disappeared. Thus the farmer, by having his property protected by good laws, has had leisure and encouragement afforded to him for the improvement of the breed and the food of his live stock. The first great improvement in this last respect was the introduction of the Swedish turnip as a field crop. This root, by withstanding the severity of our winter, enabled the English farmer to feed his cattle with green food in the winter months, and thus always to supply the markets with fresh meat; other green crops were soon after introduced, and better breeds of cattle. These had smaller bones than the old race of English oxen, and were more quickly fattened, and also of more manageable habits. The farther progress of knowledge, too, taught the intelligent farmer, that by no other means could he so well increase his profits as by improving the comfort of all his domestic animals—that, to this end, clean food, good water, regular feeding, dry and warm beds, and the most gentle usage, and perfect quietness, were the most certain means of promoting their health and prosperity. It would be well if every person, however rich or however poor, always remembered these good principles, and that they applied them not only in the management of their domestic animals, but in their families and in their own persons. The farmer here furnishes us in his practice with a most useful example. Let cleanliness and warmth in our dwellings, quiet and regularity in our conduct, be the rule for our guidance; and let us be careful to apply to ourselves the wise principles which, by long and careful observation, the English farmer has so profitably adopted in the rearing of his live stock.

SHEEP.

The sheep is an animal whose character is so changed from former days, that it little corresponds with the improved breeds of modern sheep. They were in early times coarse-bred animals, which were of value, it is true, for their coarse wool; but the mutton they afforded was inferior, and possessed only in the warmer seasons of the year a fair degree of fatness. When the growth of grass ceased, they had only the scanty, dry herbage of the fields and open country to support them during the remainder of the year. Hay must have been their only resource during the continuance of severe frosts and deep snows. Of the root-crops on which they are now fed in winter our early flockmasters had no knowledge. The first notice that exists of the growth of turnips as a field crop was not till the year 1684. Cabbages had only been first grown in England as a garden crop in 1515; mangel-wurzel only in the present century. But the feeding sheep in winter was not the only difficulty which their owners had to encounter; for they were, even more than the ox, a prey to lawless free-booters, who hid themselves in the wilds of a country then greatly covered with wood. They were obliged to be guarded day and night by shepherds, accompanied by strong and courageous dogs, who were absolutely needed to protect them from the wolves which then abounded in every extensive cover. The destruction of such enemies enabled the flockowner to devote himself to the improvement of the native breeds of sheep. The progress of knowledge, the enforcement of good laws, soon gave confidence and certainty of protection to the cultivator; and security is ever the mother of comfort. Then arose certain great farmers, who, by the wise choice of sheep, and by a firm, steady perseverance in their gentle management, at length produced the improved modern race which are so remarkable for their quiet docility, easy management, and readiness to fatten. These profitable modern improvements in the management of sheep are strangely different from the maxims which bygone races of farmers adopted. Some of the directions given on this head by the early writers on rural affairs very clearly prove the truth of this conclusion. Mankind were then only beginning to escape from the very miserable and ignorant farming practices of the dark ages; and it needs no arguments of mine to prove how very commonly ignorance, brutality, and discomfort are bosom-friends.

THE INVENTION OF LETTERS.

The first inhabitants of all countries were originally devoid of letters. They communicated their wants and wishes to each other by the voice; and then another improvement led to the use of messengers. The progress of knowledge soon led to the invention of letters. By this noble improvement manifold comforts soon arose.* Communications from distant countries became more frequent; commerce increased as the wants of different nations became known to each other; and knowledge increased on all sides. The difficulties of writing were long, however, very considerable, from the imperfection and dearness of the necessary materials. The papyrus, an oriental reed, gave the name to the first employed paper, since on the papyrus the first writings were made.† Paper, as at present known, was a much later result of increasing knowledge. It was originally made (about A.D. 1000) of cotton. Three centuries elapsed before (about the year 1319) it was made from linen rags. The pen first employed was made from a reed. It was not till about the year 553 that quills were used for pens, and those of steel only in 1830. The early writers, it is supposed, employed an ink made with lampblack. That now used, procured from blue galls, green vitriol, and gum, was a much later improvement.

The last great improvement—that of the invention of printing—then took place, about the year 1442. Before this, the progress of knowledge had been very slow. The expense and slowness of writing books had hitherto confined their use to the learned professions. The price of a book in 1400 varied from £10 to £40; double and treble their weight in gold was an ordinary value. Our Alfred the Great, King of England, gave a considerable estate for a book, in A.D. 872.

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* The invention of hieroglyphics has been ascribed to Athotes (2122 B.C.) Cadmus (1493 B.C.) brought the letters of the Phœnicians into Greece. The English alphabet contains 26 letters, the French 23, the Italian 20, the Spanish 27, the German 26, the Russian 41, the Latin 22, the Greek 24, the Persian 32, the Sanscrit 50, the Chinese 214.

† "The papyrus, or paper-reed, is a plant growing freely on the banks of the river Nile, in Egypt. Under Egyptian culture, the papyrus sprang up to the height of 15 or 20 feet; but, as now seen, it never exceeds 10 feet. The stem is bulky, gradually tapering to a point, and bearing at the top a very elegant tuft of long, loose filaments, with small, seedy flowerets. The inner bark of the stem was the portion used in making paper" (*The Useful Arts and Manufactures*, published by the Christian Knowledge Soc., p. 3).

Such were the difficulties which the young scholar had in former times to encounter. He had not then either good and cheap writing materials to assist him, or printed books to save him the labour of transcribing. The expense of learning, therefore, confined even the acquisition of mere reading and writing to a very few; and, as a natural result, ignorance abounded.

THE AVOIDANCE OF IDLENESS.

That idle people are always the most unhappy, that the best employed are those with whom the greatest happiness exists, is known to every one. So very well is this understood amongst us all, that it is sometimes admitted as a proverb that "employment is another name for happiness." The idle child soon finds out, however, that "idleness is another name for misery." The books, the lessons of an idle child are sure to be neglected; he wanders about the room, the garden, or the field, without any useful pursuit or active amusement; he is always too late for school, too late for his lessons, too late for his playmates, too late for his meals. If he is told to do anything, he leaves the performance of it until it is too late to perform it properly, or too late to do it at all. The evil, too, is here, like the child I am describing, only in its infancy. Time renders the custom inveterate; and more mature idleness opens the readiest door to sin. The greatest criminals have at the last hour, when death was near to them, been always ready to confess that from idleness, disregard to the admonitions of their parents and teachers, and a neglect of their church and of God's holy sabbath, all their crimes, their miseries, and their punishments flowed. Let not any little child say, in defence of its indolence, "I have nothing to do; I have no book to read, no lesson to learn, nowhere to play, and no one to walk with." These, although very common excuses, are very foolish, and rest on nothing but the vain thoughts of an idle mind; for every little child has the power of being employed—some task to learn, some good book to read, some little kind action to perform for his parents or brethren or teacher, some little walk of either business or pleasure to take, or some useful inquiry to make, that is better than idleness, and may be always found by the industrious. As an instance of this, let us take a survey of the case of two good little children, who had been early trained by their kind parents and teachers to avoid idleness. Let us then examine the sayings and doings of Mary and Charles, two children who had nothing to do.

LEISURE HOURS.

MARY AND CHARLES; OR, THE DOINGS OF THOSE WHO HAD NOTHING TO DO.

THE WINDOW.

MARY: This rain is very unfortunate; we are thus prevented from taking our proposed pleasant walk. I hope we are not going to have it raining all our Christmas holidays. It will keep us in-doors; and we have nothing to do, Charles.

CHARLES: When you say so, it reminds me of what our dear father told us yesterday—that when we had nothing to do, that was the very time to find plenty of useful employment in examining the history and the uses of the different things around us. Now, let us play at his game of "What and where?" or "What is it made of? and where is it made?" Let us try what we can do in this way by ourselves. How the rain drives against the window-glass! How glad I am that the glazier mended the broken pane on Tuesday; for if he had not, we must have kept the window-shutter closed, and that would have made the room dark. How is window, or crown-glass as it is called, made?

MARY: Why, I remember we were reading the other day about it in our school. It is made by melting together, in a furnace intensely heated, some fine white sand obtained from various parts of England, with some soda, to which a small portion of lime is added.

CHARLES: How very uncomfortable must English houses have been before they used glass in their windows. Whilst you have been describing to me the mode in which it is made, I have opened our book of chronology; and I there find that there were not any glazed windows in England until the reign of Henry II.*

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* The first production of glass has been ascribed by Pliny merely to an accident. He states that a vessel belonging to the Phœnicians, laden with nitre or fossil alkali, was driven ashore on the sands at the mouth of the river Belus. In cooking their meat upon these sands, the sailors, for want of stones to rest their cooking vessel upon, used lumps of their cargo. By the action of the

MARY: The glass is fastened into the frames by means of putty. Of what is that made?

CHARLES: Of linseed oil and finely-powdered whitening. Whitening is made entirely from chalk, which, for this purpose, is crushed with a heavy roller, and mixed with water into a thick cream. This cream, being run off into a settling vessel, soon deposits, by resting, all its finely-divided portion of chalk; and it is this chalk-mud thus deposited,

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fire the soda was melted, and running down amongst the river-sand, formed a glassy stream; a fact which being observed by the inhabitants, induced them to establish manufactories of glass. It was this circumstance that drew forth the well-known remarks of Dr. Johnson. "It might contribute," he very forcibly remarks, "to dispose us to a kinder regard for the labours of one another, if we were to consider from what unpromising beginnings the most useful productions of art have probably arisen. Who, when he saw the first sand or ashes by a casual intenseness of heat melted into a metalline form, rugged with excrescences and clouded with impurities, would have imagined that in this shapeless lump lay concealed so many conveniences of life as would in time constitute a great part of the happiness of the world? Yet by some such fortuitous liquefaction was mankind taught to procure a body at once in a high degree solid and transparent, which might admit the light of the sun and exclude the violence of the wind; which might extend the sight of the philosopher to new ranges of existence, and charm him at one time with the unbounded extent of the material creation, and at another with the endless subordination of animal life; and what is yet of more importance, might supply the decays of nature, and succour old age with subsidiary sight. Thus was the first artificer of glass employed, though without his own knowledge or expectation. He was facilitating and prolonging the enjoyment of life, enlarging the avenues of science, and conferring the highest and most lasting pleasures: he was enabling the student to contemplate nature, and the beauty to behold herself." For domestic purposes, the chief qualities of glass manufactured in England are: 1, flint or crystal glass; 2, plate glass; 3, crown or best window glass; 4, broad or coarse window glass; 5, coarse green or bottle glass. All these are made of silex (the base of sand) and an alkali, either soda or potash, which are melted together by intensely-heated furnaces. The difference in the quality of the glass chiefly depends on the purity of the sand and the alkali, and also upon the addition of oxide of lead, black oxide of manganese, nitre, borax, lime, and *white* oxide, and of arsenic.

when made into cakes, and dried on wooden shelves, that forms the common whitening we employ for domestic purposes. Now let us see how linseed-oil is made. It is expressed, by means of powerful wooden beaters worked by water-wheels or steam-engines, from the seeds of the common flax plant.

MARY: The glass is fastened by the putty into frames made of deal. What is deal? and where does it come from?

CHARLES: Deals are the wood of the fir-tree. The word "deal" or "*deyl*" is the Dutch name for fir-wood. They are imported into England chiefly from the countries adjoining the Baltic Sea, or from Canada, in North America. They are procured from the vast forests of these countries, are floated down their rivers to various sea-ports, and are then shipped on board large vessels, and brought into this country.

MARY: When the carpenter has made the deal window-frame, he suspends it over brass rollers by means of hempen cords. Where are these made?

CHARLES: The hemp which is used by the rope-maker is the fibres of the flax plant. This is cultivated to a considerable extent in England, and also in Ireland; but we do not grow nearly sufficient for the demands of our manufacturers, and, in consequence, it is imported in large quantities from Russia and from Australia. Brass is made by melting together about four parts of copper with one part of zinc, or the ore of zinc, which is called calamine. Being then not a metal, but a mixture of metals, it is called an *alloy*. It is melted, and cast in moulds into window-rollers, window-fastenings, and various other domestic articles of daily use. Now that we are thus following the progress of making a window, we must not forget the white paint by which it is covered and preserved. Of what is white paint made?

MARY: I remember reading about it the other day in your little book. It is made chiefly of white lead; and white lead is made by exposing common lead to the fumes of vinegar (acetic acid), fixed air (carbonic acid gas), and the air of the atmosphere. The white lead is then mixed with linseed oil; and in order to make this paint dry pretty readily, a small portion of spirits of turpentine, and of the salt called acetate of lead, is added. These cause the paint to dry with more rapidity. This finishes the window. It is then fit for use, and ready to withstand the effects of the weather. But I did not think, Charles, there were so many articles and different trades required to complete a common window.

CHARLES: Nor did I; but then, you know, our dear papa told us that the longer we played at this game, the more we should find out that we could not do a single thing in our houses, or make a single step across the carpet, or sit for one moment in a chair, without the aid of the labour and skill of very many of our fellow-creatures.

MARY: Yes. And he said, too, what I now begin to see plainly, that we very often overlook hundreds of interesting objects of inquiry close to us, in our own houses and in our sitting-rooms, in seeking after novelties abroad and at a distance.

THE WALLS.

MARY: When we concluded our last game of "*What* and where?" we had only just finished the window. It is a very amusing game. Shall we now go round the room, from the window to the fire-place?

CHARLES: I shall be very glad to do so; and let us try not to pass over anything. The window-frame is set in a brick wall. The bricks of this wall are put together with mortar, covered with plaster, and ornamented with a cornice, and then the plaster is papered. What and where of these?

MARY: Let me see in my book. Bricks are made of burnt clay or brick earth. This, for the best bricks, is dug in the winter months, is turned over with spades, or coarsely ground with water in a horse-mill. This earth is then moulded into bricks, which are dried by being exposed to the sun and wind in long piles placed so as to admit the air, and covered at the top with straw. After being thus dried, they are then burnt to the required hardness in kilns. In the neighbourhood of London, large quantities of the common refuse coal-ashes are mixed and ground with clay; and the bricks are burnt in large heaps or clamps in the open field, without the use of kilns. They owe their redness to the presence of iron in the clay. White bricks are made from clay which either does not contain iron, or in which a portion of chalk is very intimately mixed. The Bath bricks, which we use for knife and fork cleansing, are made from the fine mud of the river Avon, which flows past the city of Bath.* You know best the preparation of mortar.

CHARLES: I noticed that the bricklayers who built our new stable made their mortar of lime and sand. They first threw some water over the quick or fresh-burnt lime; and this made it smoke very much, crackle, and fall to a powder. This they called *slaking* it. They then mixed it with road-sand, and made the mixture into mortar with water. The master bricklayer told me that he used one bushel of lime with three bushels of sand for good mortar; and that the *sharper* the sand, the better the mortar. He said that *sharp* sand meant sand free from fine dust, such as river-sand, or sand well washed by the rain on the sides of roads. We must look to the dictionary for the way in which plaster is made.

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* Bricks were employed in building in very early ages. They were used at Babylon, in Greece, in Egypt, and in Rome. They were used, A.D. 44, by the Romans who invaded England. Alfred the Great directed them to be made about the year 886.

MARY: I have found it. The coarser kinds are made, it seems, of lime and sand, mixed with the hair of cattle and horses. This is added to prevent the plaster cracking and peeling off the wall. The finer kind is made chiefly of good lime, slaked, and made into a fine white thick cream, or thin mud, with water. The cornices are made of newly-burnt and powdered plaster of Paris, which has the property, when mixed with water, of *setting* into a hard substance. It is of this same material that the common statuary casts or images are made. It is a mineral substance (gypsum, or sulphate of lime—that is, lime united with sulphuric acid or oil of vitriol) found native in great masses in the hills around the city of Paris, in France (hence its name of "plaster of Paris"), and in various parts of England, such as in Derbyshire, Nottinghamshire, &c. Well, now we have got to the cornice, let us next see how the paper is made which covers the walls.

CHARLES: The paper for the walls is made of *either* cotton or inferior linen rags. These are made into paper in the ordinary way, and then the pattern stamped upon it by machinery. This kind of paper has been long in use. It was first made about the year 1555, in Spain and in Holland. Previous to its introduction, the rooms of the principal houses used to be hung with cloth or tapestry-work.

MARY: I thought we should have travelled round the room this evening as far as the fire; but the clock has struck, and we must examine the what and where of the fire at some other time.

THE FIRE-PLACE.

MARY: We had just arrived at the fire-place in our travels from the window round the room when the clock struck. Now, Charles, for the "what and the where" of the marble mantel-piece, the grate, the fire-irons, and the fender.

CHARLES: The white marble mantel-piece, you remember dear mamma told us the other day, is composed of a variety of the same mineral substance or salt called by chemists the carbonate of lime—that is, it contains only lime and carbonic acid. We all know what lime is; for we see the chalk burnt into lime at the lime-kilns, and a heavy vapour or gas arising slowly from the top of the kiln. Now this gas is the carbonic acid, which, united with the lime in various proportions, forms the chalk of the south of England, the limestone of the northern counties, and the marble of several districts of the island.

MARY: Do we meet with carbonic acid gas in any of our every-day travels?

CHARLES: Yes. We see it in the gas which escapes out of soda-water and from fermented liquors: it is the cause of their *briskness.* It is the cause of the sharp, suffocating sensation we experience when we inhale the gas escaping from the bunghole of a cask of newly-barrelled beer. It would suffocate us if we attempted to breathe it. Our mantel-piece, then, is of marble. It is set either in common lime-plaster or in plaster of Paris, and is fixed to the wall by iron clamps.

MARY: The fire-irons are made partly of iron and partly of steel. Iron is the most useful and the most extensively employed of all the metals, and has been used by mankind from the earliest ages. Moses tells us that Tubal Cain was a worker of iron. Its ores abound in England and in Wales. These ores are smelted in very powerful blast furnaces heated by the burning of coal-fires, urged to an intense heat by large bellows worked by steam-engines. The native ore, which is most commonly used, is composed of the carbonate of iron,* mixed with various earthy matters, and is the variety called the clay ironstone. Steel is made from iron, by keeping bars of iron and layers of charcoal heated to redness in a blast furnace. By this process every 100 parts of the iron gradually combine with about two parts of charcoal or carbon.

CHARLES: The grate is made of cast-iron. What is the difference between cast-iron and that which is called wrought iron?

MARY: Wrought-iron is the variety of iron which by a peculiar process is made so ductile as to be easily drawn even into fine wire, and *welds*—that is, when two pieces of wrought iron are heated till they become red-hot, they may be easily beaten together, so as to form one piece: this is called welding. Cast-iron is iron melted in an intensely-heated furnace until it melts into a red-hot liquid, which is easily taken from the furnace in iron ladles, and poured into moulds made of sand. This, when cold, keeps the shape of the mould; and in that way all cast-iron goods—our grate amongst the rest—are made. *Cast* iron will not *weld.* Now I shall ask you "the how and the where" of the fire; and please to commence at the very beginning. What do we lay our fire with?

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* *Carbonate* of iron is iron united to carbonic acid gas.

CHARLES: First with straw or paper, then wood, then some coals. We do this because these three combustible substances burn with different degrees of rapidity, and only by the application of a different extent of heat. Some kinds of flame, you must remember, have less heat in them than others

MARY: I remember now what I never thought of before—that when we play at snap-dragon, the flame from the brandy on the plums does not burn our fingers much, if we are tolerably nimble.

CHARLES: That is very true. And then, the coal requires a stronger and more enduring heat than burning paper or straw produces, to make it burn; so we use wood, which burns readily, and produces heat enough for the purpose; and then we use paper only to set light to the wood; so the coals are at last made to take fire. But different specimens of coal require a different temperature for their combustion. The kinds which are called stone coal or Welsh coal require the most heat.

MARY: What is the reason of that?

CHARLES: My tutor explained it to me the other day. It seems that the common, or *bituminous* coal, is composed of chiefly two combustible substances. These are hydrogen gas, which is very inflammable, and is the cause of the *flame* of our coal fires, and charcoal (the carbon of the chemists), which is not so inflammable, but burns away with a slow and considerable glowing heat. The *Welch* coal differs from the *bituminous* coal, in being composed almost entirely of charcoal; and hence, as it is devoid of the very inflammable hydrogen gas, it lights with much more difficulty than the bituminous coal, and burns without flame, and only well when large fires of it are allowed to burn gradually, without being chilled by being disturbed by the poker. Its dull, cheerless character, therefore, obtains for a Welsh coal fire little favour for domestic purposes. It makes, however, in properly constructed furnaces, an intensely hot fire, and is therefore preferred for steam engines and for manufacturing purposes; but, as it is devoid of hydrogen gas, it is of course avoided by the owners of gas works. The process of gas making, for the purposes of illumination, is in fact only the dry distillation of the bituminous coal. In this case, the coals are placed in iron retorts, or other close vessels; and, by the application of a strong fire to these retorts, the hydrogen gas of the coal separates, yet combined with a portion of charcoal or carbon—hence called carbonated, or carburetted, hydrogen gas—and is conveyed in a pipe to the gasometer. The charcoal of the coals remains behind, and chiefly forms the *coke* of the gas works.

MARY: What is contained in the coal ashes and in the smoke?

CHARLES: I find, by looking to the dictionary, that the ashes of Newcastle coal are composed almost entirely of sand and unburnt charcoal. The smoke which ascends the chimney from coal fires is chiefly the steam, or vapour of the water, which all coal contains, mixed with portions of soot and fixed air, and carburetted hydrogen gas. The soot of our chimneys is an impure mass partly composed of the finely divided earthy matters which coals contain, but of a still more considerable portion of various ammoniacal salts (the salt in the smelling bottle—hartshorn, sal-volatile—is an example of a salt of ammonia), and finely divided charcoal.

"Now, Charles," said Mary, laughing, "as we have got into the chimney, we must stop for this evening; though I see that there is something to be learnt, even there, more than I once supposed."

THE ATMOSPHERE.

Mary: When we last continued our travels around the parlour, we examined the "what and where" of the fire and the fire-place, and I was very much interested in the result of our enquiries as to fuel. But we only then had time to examine the coals and wood. Now, papa says we left out of our enquiry the air, without which it could not burn. "What and where" of this?

Charles: It is quite certain that coals or candles will not burn without air. We put out a candle by an extinguisher, which deprives it of air; and, you know, when our German stove in the hall gets too hot, we cool it by shutting the doors of the fire-place and of the ash pit. So that air is as necessary for the continuance of a fire as for the breathing of animals.

Mary: But did not dear papa show us a little experiment the other day to explain to us that it was only a portion of the air of our atmosphere *which keeps* the fire burning?

CHARLES: He did. He took a soup plate, about half filled with water; and having placed a thin piece of cork in the middle of it, he then lighted a small piece of dry paper, and laid it, whilst burning, on the cork: he then inverted a large tumbler over the cork; and then, you know, we saw that, as the burning paper consumed the air inside the glass, the water and the cork rose into the glass—but only to a certain height; for the fire, as the cork arose, gradually burned more feebly; and, when about one-sixth of the air was consumed, it quite ceased to burn; and all we could do, you remember, we could not make the paper burn a larger proportion of the air.

MARY: And then we found, upon looking to the dictionary, that this portion of the air which fire consumes is called by chemists oxygen gas, or vital air, and that it forms about 21 parts in every 100 parts of the air we breathe.

CHARLES: Exactly so. And then I also remember that papa explained to us that if, instead of placing the lighted paper under the inverted tumbler, we had placed there a small animal, such as a mouse, that he also would consume the same portion of air that the lighted paper did; and that then, after he had inhaled this portion he would have died of suffocation.

MARY: What is that portion of the atmosphere composed of, which animals cannot breathe, or fire consume?

CHARLES: I find it described in our dictionary. It is called by chemists nitrogen gas, or azote. It is that portion of the air we respire, or return from our lungs in breathing. It forms about 79 parts in every 100 parts of the atmosphere. This, when rejected from the lungs, is mixed with a considerable proportion of fixed air, or carbonic acid* gas; and this last is the portion of the air which all plants growing in the light absorbs through their leaves.

Mary: What, do plants also breathe?

Charles: We may call it breathing; for they inhale through the minute pores of their leaves, when growing in the light, the very gas (carbonic acid gas, which is found in the atmosphere in the proportion of about 1 part in a 1000 of air) which all animals respire from their lungs; and plants emit the very gas (oxygen gas) which we and all animals as constantly need for our consumption. So that, as the author of the book I am referring to says, the two great classes of organized beings (vegetables and animals) mutually support each other: what is useless or pernicious to the one, imparts vigour and health to the other. The exhalations and bad air, which spread disease and death in thickly inhabited places, give fresh life and vigour to the plants of the field.

Mary: Then this is the reason why the gardener says sometimes that our plants in the cucumber frames "want air," and why he opens the window between our greenhouse and the stable. He told me the other day that it did his plants good. I did not know then why he preferred for his plants the close smelling air of the stable to the air from outside the greenhouse. But I understand it now;

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* The correct composition of the atmosphere by weight is as follows:

Nitrogen	75·55
Oxygen	23·32
Aqueous vapour	1·03
Carbonic acid gas	0·10

he wanted his plants to inhale the air spoiled by the horses.

Charles: To be sure he did. These things are not nearly so difficult to understand, when we come to examine them, as I imagined. I see, too, that the more we study the effect of breathing bad air, the more we see the goodness of the Creator, in providing such nice beautiful plants and flowers, not only to please our eyes, but for the purpose of performing, quietly and unseen, and unthought of by thousands of us mortals, the absolutely essential office of purifying the air we breathe.

THE CURRENTS OF AIR IN A ROOM.

Mary: What did papa mean last evening, in telling dear mamma that there was a less current of air in the room when the window shutters were closed and the curtain was drawn? I thought that a current could only be caused in air, or in other fluids, by their running from one place to the other, and not by the air moving from one side of the room to the other?

Charles: Yes it can. Our tutor was showing us that, by a little experiment, not long ago. I remember his words very well. He told us that it is caused by the action of the fire on the air of the room. For the effect of the fire upon the portion of the air of the room, next to it, is to warm it and rarefy it. It is thus rendered *lighter* than the colder air of the other part of the room; and, consequently, the colder (and also heavier, since less rarefied) portion of the air descends to the bottom *of the room,* from the side walls or window, which *are in winter* generally the coldest parts of the room. This constant rising of the warm air, and the descent of the colder portion, is the more rapid, the colder the sides of the room; because then the cooling or condensation of the air is the greatest. Now, in cold weather, the most rapid and powerful coolers of the air are the panes of glass, which often only separate, by a thin plate of glass, the warm air of a room from a freezing temperature without. Near them, in consequence, is sure to be found a descending cold current of air, to which many a winter's cough may be attributed.

MARY: But why is this current lessened by the closing the shutter and the drawing of the curtain?

CHARLES: Because, by so doing, the warm air of the room ceases to be in such free contact with the cold glass. It can then only find its way to it (which it still does partially) by moving around the curtain and behind the shutters. The current, it is true, is still not entirely stopped; but the *volume*, or bulk of the stream of cold air, is diminished very materially: the warm current of air caused by the fire then still continues to arise, and still descends near to the walls; but its temperature is less reduced, and the current it forms is, in consequence, diminished and less injurious. The room gets warmer, and the consequent comfort of the family circle so much promoted, that, in winter, every one is apt to wish for "curtain drawing time."

MARY: Did not the little experiment our papa made with a lighted candle, in the parlour doorway, show the currents moving in and out of a room at the same time?

CHARLES: It did, and it is a very easy one indeed to repeat. When the door of a room, in which a warm fire has been burning for some time, is opened, two currents of air may be immediately noticed; the warmer, or lighter air, flows *out* at the *top* of the doorway into the colder passage; the cooler, and consequently heavier, air of the passage flows *into* the room from without at the *bottom.* Here we have an instance perceptible to our senses of two currents of air flowing in different directions through a doorway at the same time. If we place a lighted candle on the *floor*, the flame will be inclined by the current of air *into* the room. If we raise the candle into the *centre* of the doorway, there being there no perceptible current, the flame rises quite upright; but, if we raise the candle to the *top* of the door, we find the current of warm air, which is flowing *out* of the room, causes the flame to incline *outwards.*

Mary: How very curious these currents of air seem to be! But, then, they must be very good and wholesome for us; for if there were no currents of air in the room, and in and out of it too, we should be soon too hot if we sat by the fire, and too cold if at a little distance: the warm air would not mix well with the cold. And then how bad it would be to breathe it! It would never get changed in any room sufficiently closed to keep out the weather. Does the application of heat in other fluids produce a current?

Charles: It does—in water, for instance; but that must be the subject of another evening's travels.

THE CURRENTS OF WATER IN A TEA-KETTLE.

Mary: When we were last employed on our "What and Where," you alluded at its conclusion to the currents produced by heat on other fluids besides air. Shall we examine them? and as to the currents in warming and cooling water?

CHARLES: Do you not remember how papa explained this one evening over the tea table? He told us, I recollect, that as soon as a vessel containing cold water is placed over a fire that the portion of the water nearest to the fire, becomes heated first, and in consequence expands, and so becoming lighter, rises to the top; that the cooler portion of the water descends as the warmer portion arises, and this produces a current in the water of the tea kettle which continues gradually diminishing until all the water becomes of a boiling temperature, when the current of water is at last so very slow that the portion of it at the bottom of the kettle next the fire remains there so long as to be converted into bubbles of steam, which, rising through the water, causes what we call boiling, or ebullition. So that you see there are currents of water even in a tea-kettle over the fire.

MARY: I remember, too, that papa *showed* us that these currents also take place as hot water *cools*, by placing a large glass tumbler full of boiling water in the strong light of a candle; for we then saw that, as the water cooled, some fine particles of dust which it contained, kept streaming in a little current *down* the *out-side*, and kept *rising* up the *centre*, of the water.

CHARLES: To be sure it does; and you may make the same little trial by placing the tumbler of hot water in the strong light of the sun's rays, instead of against the candle. The current is in this case caused by the water cooling fastest on the out-side; *it therefore* becomes heavier, descends, and by its descent causes the warmer and consequently lighter portion to *rise* in a little current to the top, through the *centre* of the water.

CHARLES : Certainly it did; and the same current is thus produced in every tea-kettle; and the current runs on, not only there, but in our tea-pots, and our tea-cups. And, as dear papa said, it is a fortunate and a beneficent arrangement of God, that these little currents do exist in water; if they did not, a vessel of water, like a poker placed in the fire, would only be warmed at the end next the fire.

THE CHAIRS AND TABLES.

MARY : When travelling round the room, we must not forget to examine the furniture—the tables and the chairs.

CHARLES : They are made of mahogany; the pieces of which are fastened together by either screws made of iron, or pegs of wood, or by glue. What is mahogany, and where does it grow?

MARY : Mahogany comes from South America; it is the wood of the mahogany tree, and is usually employed for our furniture from its hardness, durability, freedom from warping, and the fine polish which it takes. Its wood, when thus employed, becomes harder by age, and of a darker colour. Other woods are occasionally used, but few of them can compare for the purpose with mahogany.

CHARLES : We little think, when we are sitting at our comfortable meals, how much we are all indebted to the sailor who brings us this valuable wood, and to the sawyers and cabinet makers, and the varnish makers, and the screw maker, and the glue maker, before we can have even a mahogany table in the room. Now for the glue, "what and where?"

Mary: I must look to my book again, before I answer. I have found the place. Glue is made, in various places in England, from the refuse portions of animals, which the leather dresser and the parchment maker reject, such as the roundings, flaps, and cuttings of skins. It is called gelatine by the chemists, and is found, in commerce, in various forms. Isinglass is one variety of gelatine; the best of this is made in Russia, chiefly on the banks of the great river Wolga, from some of the inner portion of a fish. There are many other varieties of this gelatine; the jelly we are so fond of, and the soups, which become so solid and semi-transparent when they are cold, are all varieties of gelatine. And you remember that all these have sometimes a tendency to make our lips adhere together, just as the highly concentrated glue or gelatine of the cabinet maker and the carpenter makes pieces of wood unite together. You visited, not long since, with papa, a manufactory where screws were made, "what and where" of screws?

Charles: The screws I saw made were of iron, such as the cabinet maker and carpenter employ. Screws, you know, are also made of wood, of bone, ivory, brass, and of many other materials, chiefly, however, by the use of a lathe—that is, by the turner. At the manufactory I visited with dear papa, at Birmingham, the screws they make are all of iron; and they are made by manual labour, with the aid of lathes.

Mary: How very interesting all these manufactories are! It seems an endless source of amusement and instruction to examine either them or the accounts which so many clever books give of them. The more I read, however, of them, the more I see the force of dear mamma's observation the other evening—that it is impossible to walk in at the parlour door, and sit down on the chair by the fireside, without hundreds of artisans, and labourers, and miners, and sailors, having been employed to minister to our wants and comforts, and to extend our enjoyments.

MARY, CHARLES, AND THEIR FATHER.

THE INFLUENCE OF LIGHT.

MARY: We have examined, in our "What and where" travels together of an evening, some of the various articles in the room; but we could not have done this so well without the aid of the candle. "What and where," then, of light?

CHARLES: I must refer to my Dictionary. It seems that light is emitted from various sources, as from the sun, by burning bodies, by electricity; by various phosphorescent animals, as the glow-worms and fire flies, and even by friction. For instance, if you take and rub two pieces of *lump* sugar together in a perfectly dry and dark place, you will see a faint light at the point of contact—that is, where the two pieces of sugar touch each other.

MARY: The use of light, then, we may say, is only to enable us to see other bodies?

Mr. ASHWORTH: No, my dear Mary; that is a very false, though a very common, conclusion. Light affects both animals and vegetables in a very remarkable and a very important manner.

MARY: How does light affect animals, Sir?

Mr. Ashworth: In various ways. It is certain that the young of all animals are retarded in their growth by the absence of light. If tadpoles are kept in the dark, instead of growing into frogs they only become larger tadpoles—they increase in bulk, but tadpoles they remain. Then again, it has been remarked by very intelligent and observant medical men, that persons living in dark rooms and streets are always more unhealthy than those who live in rooms better supplied with light.

Mary: I am sure it affects our spirits, for we all know that we never feel so happy and so cheerful on a dark gloomy day, as when the sun shines bright. The very birds seem to feel in the same way as we do. For as soon as ever the gloomy days of winter are over, how very soon there is the lark and other birds heard! But how, Sir, does light affect plants?

Mr. Ashworth: In a very remarkable manner. To light, plants owe all their green colour. A plant growing in the dark is of a pale yellow colour. The gardener is well aware of this, for when he wishes to blanch his lettuces or endive or sea-kale, he deprives them of light by turning an earthen pot over them; they then, it is true, contrive to vegetate, but their green colour speedily departs. If they are exposed to the light again, their green colour gradually returns. Light, too, affects what may be called the breathing of plants in an equally remarkable manner. All plants growing in the light absorb from the atmosphere, by means of their leaves, fixed air, or carbonic acid gas; and at the same time they exhale oxygen gas, or the vital air which animals breathe, and hence the effects of plants in our *sitting* rooms is to purify the air. But if these same plants are made to vegetate in the dark, this process is completely reversed. For in the dark they *inhale* from the atmosphere oxygen gas, and they *emit* carbonic acid gas; so that plants growing in *bed* rooms tend to vitiate the air for those who sleep there.*

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* The reader must not suppose that the apparently opposite chemical results produced by the action of light and its withdrawal are phenomena, not forming part of a wise and unerring arrangement of creative wisdom. "It is true," says Dr. Liebig, "that the decomposition of carbonic acid is arrested by the absence of light; but then—namely, at night—a true chemical process commences, in consequence of the action of the oxygen in the air upon the organic substances, composing the leaves, blossoms, and fruit. This process is not at all connected with the life of the vegetable organism, because it goes on in a dead plant exactly as in a living one. The substances composing the leaves of different plants being known, it is a matter of the greatest ease and certainty to calculate which of them during life should absorb most oxygen by chemical action, where the influence of light is withdrawn. The leaves and green parts of all plants containing volatile oils, or volatile constituents in general, which change into resin by the absorption of oxygen, should absorb more than other parts which are free from such substances. Those leaves, also, which contain either the constituents of nut-galls, or compounds in which nitrogen is present, ought to absorb more oxygen than those which do not contain such matters. The correctness of these inferences has been distinctly proved by the observations of De Saussure; for whilst the tasteless leaves of the *Agave Americana* absorb only 0.3 of their volume of oxygen in the dark during 24 hours, the leaves of the *Pinus abies*, which contain volatile and resinous oils, absorb ten times; those of the *Quercus robur*, containing tannic acid, fourteen times; and the balmy leaves of the *Populus alba*, twenty-one times that quantity. This chemical action is shown very plainly also in the leaves of the *Cotyledon calycinum*, the *Cacalia ficoides*, and others; for they are sour like sorrel in the morning, tasteless at noon, and bitter in the evening. The formation of acids is effected during the night by a true process of oxydation; these are deprived of their acid properties during the day and evening, and are changed, by separation of a part of their oxygen, into compounds containing oxygen and hydrogen, either in the same proportions as in water, or even with an excess of hydrogen, which is the composition of all tasteless and bitter substances. When the green leaves of the poplar, the beech, the oak, or the holly, are dried under the air-pump, with exclusion of light, then moistened with water, and placed under a glass globe *filled with oxygen,* they are found to absorb that gas in proportion *as they change in colour.* The chemical nature of this process is

MARY: These are very curious facts, sir. But I had no idea before, that light had so much influence upon our well-being, as I now see it has. Although I *have* noticed our gardener covering up his plants, I never thought what was the explanation of it.

Mr. ASHWORTH: And so it will always be, my dear children, in every step we take in life, if we do not adopt a regular habit of inquiry on all proper and fitting occasions; and we shall find from the result of such inquiries, the infinite wisdom and bene-

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thus completely established. The diminution of the gas which occurs can only be owing to the union of a large proportion of oxygen with those substances which are already in the state of oxides, or to the oxydation of the hydrogen in those vegetable compounds which contain it in excess. The fallen brown or yellow leaves of the oak contain no longer tannin, and those of the poplar no balsamic constituents."—(*Organic Chem.* p. 30.) The action of light on plants, and the effect they produce upon the composition of the atmosphere, did not escape the notice of Sir Humphry Davy. After giving a variety of experiments to elucidate the action of vegetation on the atmosphere, he adds (*Agri. Chem.*, p. 223), "These facts confirm the popular opinion, that when the leaves of vegetables perform their healthy functions, they tend to purify the atmosphere in the common variations of weather, and changes from light to darkness. It may occur, however, as an objection to these views, that if the leaves of plants purify the atmosphere towards the end of autumn, and through the winter and early spring, the air in our climates must become impure, the oxygen in it diminish, and the carbonic acid gas increase, which is not the case; but there is a very satisfactory answer to this objection. The different parts of the atmosphere are constantly mixed together by winds, which, when they are strong, move at the rate of from 60 to 100 miles in an hour. In our winter, the south-west gales convey air, which has been purified by the vast forests and Savannas of South America, and which passing over the ocean, arrives in an uncontaminated state. The storms and tempests which often occur at the beginning, and towards the middle of our winter, and which generally blow from the same quarter of the globe, have a salutary influence. By constant agitation and motion, the equilibrium of the constituent parts of the atmosphere is preserved; it is fitted for the purposes of life: and those events which the superstitions formerly referred to the wrath of heaven, or the agency of evil spirits, and in which they saw only disorder and confusion, are demonstrated by science to be ministrations of divine intelligence, *and connected* with the order and harmony of our system."

volence of the Supreme Being, by whom all things were made and regulated.

WARMTH OR TEMPERATURE.

Mr. Ashworth: In the progress of our little game of "What and Where," we have directed our attention to the light of the candle. Can we not find something interesting in the same way on the subject of warmth or temperature—Caloric as the chemists call it?

Mary: Why, papa, I dare say there is something interesting about that, though I do not know what, only that it is very pleasant and comes from fire.

Mr. Ashworth: Yes; but it comes also from other sources too. It is sent to us from the sun, and is also produced from friction, by rubbing two pieces of hard dry wood or iron togther; or by percussion—that is, by merely hammering a piece of iron.

Charles: I remember now that the iron axletree of the stage-coach became hot in this way, the last time we went to London: that was by friction.

Mary: But, papa, the sun is at such an immense distance, can the heat possibly come all that way?

Mr. Ashworth: It does; and by the goodness of God, it is provided for our existence. Heat travels in various ways, though at different degrees of rapidity. Can we not think of some of these?

Charles: I have noticed, sir, that if I put my hand *over* the candle, that it burns even at a considerable distance from the flame; but I may place my finger almost in contact with the flame on the *side* of the candle without its being too hot.

Mr. Ashworth: Just so. It is, in fact, well known that heat travels *upwards* much faster than in any other direction. Do you remember any other instance of this?

MARY: Yes. Our cook says that the water in the *side* boiler in the kitchen range is a long time before it boils, however hot the fire is; but then the great iron tea boiler placed *over* the fire boils, we all know, very readily. In the one case the heat travels upwards, in the other sideways.

CHARLES: And I have noticed, sir, that when our iron poker is placed in the fire, with its handle *below* the level of the bottom of the fire, that then the handle remains cool; but if I place the handle *above* the fire, that then it very soon becomes too hot to hold it: so the heat, it is certain, travels *upwards* along the poker handle much faster than it does downwards.

Mr. ASHWORTH: Does the material of which the boiler is made produce any difference in the rapidity with which the water boils?

MARY: Oh, certainly. In earthen pots the water boils very slowly; and you know that dear mamma was saying the other night, that in the iron tea-kettle the water became boiling hot much slower than in our old copper kettle which was then gone to be mended.

Mr. ASHWORTH: Why do you suppose this is so?

CHARLES: Because heat passes from the fire through the earthen ware more slowly than through the iron, and more slowly through the iron than through the copper.

Mr. ASHWORTH: Exactly so. The chemists therefore say, that earthenware and iron are worse *conductors* of heat than the copper.

Mary: Well, papa, I was just thinking that heat cannot travel or be conducted at all through some bodies, for I remember that our iron pots in the kitchen have wooden handles, and that the end of these handles are always cool, although the iron into which they are fixed is so hot that our cook burnt her hand with it the other day.

Mr. **Ashworth**: Very true. Wood is a very bad conductor of heat, and therefore the boiler-maker gives his vessels wooden handles. Again, woollen cloth, or worsted, is an equally bad conductor of heat. Do you remember any instance of this?

Mary: I do, papa. We have a worsted kettle-holder, of my making, for our copper tea-kettle, and you may hold the kettle with it as long as you please without the handle feeling too hot.

Mr. **Ashworth**: Certainly. Woollen cloth, then, you see, is another bad conductor of heat, and this is the reason we use it for other purposes. Do you remember any of these?

Mary: For our clothes, and our carpets, and curtains, and our bedding.

Mr. **Ashworth**: But why do we use for these purposes woollen fabrics instead of other substances?

Mary: Because they would be so cold, sir.

Charles: Yes, I see now, it is because woollen clothes conduct away the heat from our bodies so much slower, that we prefer them to other substances.

Mr. **Ashworth**: It is so; and then again, these substances contain air between their fibres; and air, when quite still, is a very slow conveyer of heat. *But we* all know that air in motion, that is a *current of air, makes* us cold, thus showing that it carries off the heat from our bodies much more quickly than still air.

CHARLES: I remember now, sir, that when I am dressing in a cold morning, that if I *move* about, I am much more cold than if I keep as quiet as possible. My moving, I suppose, produces a current of air; and it is the current of air which carries off the warmth of my body, and makes me feel cold.

Mr. ASHWORTH: Certainly it does; and anything which retards the current of air, retains the heat. When we are in bed quite quiet, even in a room at the freezing temperature, we are warm, because the escape of our animal warmth is retarded by the blankets, which retain the air between their coarse fibres. And yet as soon as we arise, and begin to move about, so soon do we feel compelled, however warmly clad, to have fires to warm the room; because the movement of the air in our sitting rooms, although warmer than that of our bed rooms, begins to carry off the heat from our bodies with greater rapidity.

MARY: Then it is for these reasons that my fur is so much warmer than linen, and why worsted carpets are always said to make a room warmer than oil cloth?

CHARLES: And why, I find that if I wear very tight clothes in winter, I am much more cold than when I wear clothes that hang rather loosely about me?

Mr. ASHWORTH: Certainly it does. And God seems to point these things out to us in all directions, if we would but notice them. Animals, when taken from a warm climate to a colder, become covered with a thicker, longer, and much warmer *coat, through* which the air can only circulate slowly.

Even our own horses, and other domestic animals, experience this change against winter; and if we change their climate, the change in their coats becomes permanent.

MARY AND CHARLES.

THE FALLOW FIELD.

MARY: I think, Charles, now that we are enjoying our Midsummer holidays, that we must try our old game of "What and Where" in the fields, which we liked so much at Christmas in our parlour.

CHARLES: I am quite ready; but then as we shall be without our books in the field, we must enquire of the farming men, and of our neighbour, Farmer Williams.

MARY: Of what use is it to let the field remain without any crop? I remember that when I was last at home, that the ploughmen were at work in the field before our house, and they were again ploughing it this morning.

CHARLES: Oh, that I can understand; it is to kill the weeds: they call it a fallow. They first plough it, to loosen the soil; then they use a heavy set of harrows, or an implement they call a scarifier; this brings the weeds up to the surface, where they are either killed by being dried in the sun, or they are gathered into heaps and burnt: and then again, if the land is full of hard clods, they are obliged to have a fallow every now and then to break these great clods sufficiently for the plants of the next crop to root in.

MARY: There is Farmer Williams, let us ask him *to explain to us* why he makes a fallow.

***FARMER* WILLIAMS**: I have been making this summer fallow, because I want to cleanse the land from weeds, and it is now nearly finished, and then, in a day or two, I shall sow turnips, and these will be ready by November for my sheep and cows, and find them in green food from that month, when all the grass is either eaten or gives very little nourishment, nearly to the time when the young sweet grass of spring begins to afford a bite for my lambs, and sheep, and cattle.

CHARLES: Pray, sir, will you be so kind as to tell us why you always grow your turnips and cabbages on little ridges in the field? Does not that make their roots very dry?

FARMER WILLIAMS: Why that was what we formerly thought; but we find now that by planting them in this way they grow the best, because the air and the invisible moisture which the air contains, in all seasons, finds its way the better to the roots of the plants which are raised out of the soil on these ridges, than they do when they are on a more close level surface; and the more air the roots have, the better they grow.

MARY: What do you mean, sir, by the invisible moisture of the air in all seasons?

FARMER WILLIAMS: All air has water mixed with it, even in the hottest and driest day of summer. You can find that out at any time, by bringing into your parlour a glass vessel full of *very cold water;* for you will see a cloud of dew settle on the outside of the glass. This is the invisible vapour of the air condensed by the coldness of the water in the glass. It is commonly thought to be the *heat* of *the room* which produces this cloudiness upon the glass, but this is an error; it is the invisible moisture contained in the air of the room which is thus rendered apparent to our senses.*

Mary: I thank you, sir, for your very kind explanation. I had not any idea that there was any moisture in the air in the dry weather of summer. Does the air contain any other substances?

Farmer Williams: Why, yes: it contains the matters which are emitted during the putrefaction of animal and vegetable matters, and by fires. Many of these are deposited on the earth by the rain, for which, I think, we cannot be sufficiently thankful. Since these matters, I know, render even the rain more nutritive to my crops. The rain thus does good in two ways, not only to my land, but by bringing down those matters, which, if they had been allowed to accumulate in the air, would soon, by rendering the atmosphere unwholesome, have given rise to many bad diseases.

MARY, CHARLES, AND FARMER WILLIAMS.

THE CORN FIELD.

Charles: I see, sir, that your men are now drilling-in barley; and this is the field where you were so kind, last summer, as to talk to us about the turnips. Why do you not sow turnips here again?

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* The average ordinary amount of the invisible moisture of the atmosphere is, by weight, about 1.03 per cent. Davy was struck with the importance of the services rendered by this aqueous vapour to plants. He observes (*Ag. Chem.*, p. 207), "The leaves of living plants appear to act upon the vapour in its elastic form, and to absorb it. Some vegetables increase in weight from this cause, when suspended in the atmosphere and unconnected with the soil: such are the house leek, and different species of the aloe. In very intense heats, and when the soil is dry, the life of plants seems to be preserved by the absorbent power of their leaves: and it is a beautiful circumstance in the economy of nature, that aqueous vapour is *most abundant in the* atmosphere when it is most needed for the *purposes of life, and* that when other sources of its supply are cut *off, this is most copious.*"

FARMER WILLIAMS: I am obliged to change my crops, not only because I must grow many other things besides turnips, but because the land *likes*, as we say, a change of crops. And we find that it is not a mere change of crops that is required for the sake only of making a change: we sow barley or oats after turnips, and very often we sow clover and grass-seeds amongst those corn crops; and then we have a quantity of young grass, which keeps rooting and establishing itself in the corn all the summer, and then in the next spring we have a crop of clover, or grass for hay or for pasture for our cattle and horses.

MARY: And what, sir, do you grow next?

FARMER WILLIAMS: Why, after the grass is all gone, we plough the land again, and sow wheat about Michaelmas. This young wheat remains in the ground all the winter, and then is ripe in the following July or August. I then plough down the land from which the wheat is gathered in, and begin either to fallow the land again for another crop of turnips, or I sow the land with vetches or tares. These tares begin to grow during the same autumn and following winter, and are very good, sweet food for my horses and cows in the next spring. I manage to have these tares all consumed during the spring, in time for beginning and concluding a summer fallow for turnips. And this is what we call a four-course rotation—that is, in every four fields, if you visit my farm in July, soon after the fallows are ended, you will find in one field turnips growing, the second has a crop of barley or oats, the third has clover, the fourth has a crop of wheat.

CHARLES: I see that your men, as they drill the barley, do not guide the drill directly up and down the furrows, but *across*. Why is that, sir?

FARMER WILLIAMS: You are right. They do so; and for this reason—that the rows of barley may run east and west. If they were to drill up and down the lands, which is the way the field slopes, the rows of barley would grow in the direction of north and south.

MARY: But what benefit do you derive, sir, from having the rows extending from the east towards the west?

FARMER WILLIAMS: By causing the rows to grow in that direction, I have the full advantage of the fine westerly breeze more freely circulating amongst the corn plants. And the more air my plants get, the better I find they grow. This I attribute also to the insensible moisture of the air, and its gases nourishing the young corn. We all know that in fine moist westerly breezes of the warm season of the year all our young crops improve in their appearance.

MARY: Why, then, that is the reason that mamma sets her pots of flowers and plants out into the garden in summer. She says, indeed, as you do, it is to give them air.

FARMER WILLIAMS: Certainly. I fancy that all our crops would be but poorly off if they had not a constant supply of air: and, as my neighbour our rector told me truly enough yesterday, while the wind was blowing so hard, "There is health and plenty borne to us in every gale that visits us. It nourishes our crops; it purifies the air from unwholesome and stagnant gases; and even when *it does sometimes* rage with violence, yet it is still *obeying the* commands, still diffusing the blessings *of an Infinite* Benevolence."

MARY, CHARLES, AND THE FARMER'S LABOURER.

THE GRASS FIELD.

Mary : What is that labourer gathering together in the meadow, Charles? It must surely be hay-seeds. Let us ask him.

Labourer : I am gathering hay-seeds. To have a good turf, we want a great many sorts of grasses.

Charles : Why will not one kind do?

Labourer : Because, if we sowed only one kind of grass-seed, we should have only one kind of grass; and then, when that grass had ripened its seeds, we should have no more green grass for the rest of the summer.

Mary : Then, when you gather grass-seeds, how do you arrange it?

Labourer : Why, master sets me to gather the seeds first in June, because then the seeds of the grasses begin to ripen. In that month the sweet-scented vernal grass, the meadow foxtail, and several others, are ripe. Then in July I gather grass-seeds again; for the oat-grass, the smooth meadow-grass, and many others, are then ripe. In August, again, I find other sorts, such as several of the wheat-grasses, the golden oat-grass, the long-rooted clover, with their seeds ripe. In September there are, with several others, the foxtail oat, the fiorin, the couch-bent ripe. In October only a few grasses ripen, such as the common reed-grass and the stiff wheat-grass.

Charles : I see the reason now. If you used only the seeds from a hay-loft, you would only get the grass-seeds which are ripe at hay-harvest; and *then, if you* sowed these seeds, your cows would have nothing to eat in the pasture after that time of the year.

MARY: There is a man laying down some draining pipes at the lower end of the field. Do you drain meadows? Does not the grass always grow best in the wettest places?

LABOURER: Yes, miss. Grass likes damp, cool ground, it is certain; but it does not like too much. If grass has too much water, the rushes and other water-grasses come. They look very pretty; but they are of no use to master, for his cows and horses won't touch them. So he drains the water off, and then the rushes can't grow.

CHARLES: But what grows then?

LABOURER: Why, all sorts of wild grasses come up instead of them. The land is always full of seeds. The wind and the birds bring them, I suppose.

MARY: What makes you think there are seeds of the wild grasses in the land?

LABOURER: Because I see that when master drains the meadow, or applies certain manures, up comes a great deal of fresh sorts of grass; and yet he don't sow any seed. If you look down on the right hand side of that open drain, just by where those sheep are feeding, you will see that the grass on that spot is full of white clover. Now there master spread, last spring, a white powder they call gypsum. He never sowed any white clover-seeds; but I soon began to see the young clover coming up as thick as the hair on a cat's back; and it was just the same where we spread some bone-dust on the home-pasture two years since.

MARY: I see it—it *is* thick. But surely the *seeds of the clover* cannot be in the land. Can they *not be formed in it*?

Labourer: Why, it does seem comical that the clover should grow without sowing the seeds; but when some one said to master the other day that the seeds were made by the land, he wouldn't agree to that story at all. He said, if he could believe that, he should believe that the land might also form a young colt or a young calf; but he never heard of their being *made* by the ground. And yet, as he says, if the ground *formed* a young clover-plant or a young tree, it might, for aught he saw, form a horse or a sheep.

Charles: That seems very true; and, as our dear papa said the other day, every plant—even the most minute—is formed by God, and nothing by chance. Every plant comes and goes, ripens its seed and dies, at its appointed season; everything is in its place; there is neither confusion in their growth, nor irregularity in the laws which God assigned to them.*

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* The apparently spontaneous growth of certain peculiar plants, in what appears to be very unlikely situations, are phenomena which often arrest the attention of the farmer. If they do not lead him to adopt, as an explanation, the old and now exploded doctrines of spontaneous generation, it is because the march of science has led to the conclusion that such a phrase is a mere subterfuge for ignorance—an attempt to explain unknown things by unmeaning verbiage. The doctrine of spontaneous generation, in fact, as Dr. John Walker well observed in a letter to Lord Kames (*Memoir*, vol. ii., app., p. 56), is a doctrine that can only subsist where human knowledge and human understanding are but in a glimmering state. In such a state philosophers saw mites generated from rotten cheese, and myriads of flies and creeping things arise from a dunghill or putrid marsh. Ignorant of the natural history and generation of these animals, they concluded them to be mere spontaneous productions, and the effects not of generation but of corruption! To add to their folly, the degrading doctrine never was extended to a lion or a horse, but confined to the poor insects, merely because they were creatures of whose nature they were ignorant. They knew not that the same power and wisdom were necessary to form a maggot that are requisite to produce an elephant. They *formed the* same conclusion concerning many vegetables whose *seed escaped* their eyes, such as the ferns, mushrooms, and mosses

MARY, CHARLES, AND THE HAYMAKER.

THE HAY FIELD.

MARY: How very sweet the new hay smells, Charles! They are gathering it into cocks. Why do they do that?

Because they did not see the seeds of such vegetables, they readily concluded that they had none; and while the oak and the laurel were dignified with generative qualities, these plants were classed as the progeny of putridity. Equivocal generation thus readily became the asylum of their ignorance.

It is true that many phenomena of vegetable life, in cases like these, startle and confound us. The lands of many of the farmers of the Essex side of the valley of the Thames, if ploughed only an inch or two deeper than usual, abound immediately with the wild mustard plant. Even the soil thrown out during the excavation of deep wells produces these. Other instances are well known, where bones, gypsum, &c., being spread, produce the abounding growth of white clover. The site of a fire is speedily tenanted, in the same way, by totally different plants from those growing around the spot. Liebig alludes to other instances of a similar kind (Organic Chemistry, p. 152). After the great fire of London, it seems large quantities of the *erysum latifolium* were observed growing on the spots where a fire had taken place. On a similar occasion the *blitum capilatum* presented itself at Copenhagen, the *senecio viscosus* in Nassau, and the *spartium scoparium* in Languedoc. After the burning of the North American pine-forests, poplars grew on the same soil—facts just as incomprehensible to the bye-stander as fairy-rings are to even the modern husbandman. Let us, then, before we examine the cause of these appearances of peculiar plants, banish from our minds all dreams about the spontaneous generation of plants. Let us rest assured that the seeds of the plants produced by creative wisdom have numberless ways assigned to them for their dispersion and the lengthened preservation of their vitality, which, although we can, perhaps, but partially discern, are fully sufficient to render unnecessary any evidence that He who made them has amply provided for their dissemination and preservation in the soil. What we do see assures us of these things, even in the commonest plants around us. For instance, as Professor Walker remarked, the ash and the plane have heavy seeds, but they are supplied with wings. A gale of wind can carry them from their original lofty situation to a considerable distance, *and they remain on* the tree till that gale arrives. The seeds of the *more humble plants,* that they may rise and be dispersed, spread *their sail to the wind.* The thistle spreads his beard, and away he

CHARLES: I suppose it is to make it more handy in carting it; but let us ask this man with the hay-fork.

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travels to fix his residence in remote parts. The seeds of plants, once removed to a distance by the winds to their appropriate soils, rapidly vegetate. In some other cases they are carried by insects, or by other causes, deep into the soil, where they preserve their vitality for a lengthened period. The modern farmer will remember the variety of mummy wheat recently raised from some seeds found in an ancient Egyptian tomb, as a well-known instance of the vital tenacity in the seeds of plants. We need not, therefore, trouble ourselves with needless doubts as to the dissemination and preservation of seeds. Once conveyed to the soil, those seeds are certain to vegetate with the greatest rapidity whose inorganic ingredients the most abound in, and are copiously furnished to the plant in, the products of the fires to which we have alluded. The phosphate of lime for instance, and the alkalies produced by the combustion of wood-fire, have thus their sites speedily occupied by white clover and other grasses, in which these salts abound. The very same result is obtained by the application of the same salts, procured from other sources, to the soil. Liebig has noted some of these things. "It is not mere accident," he remarks (*Organic Chem.*, 151), "that only trees of the fir tribe grow on the sandstone and limestone of the Carpathian mountains and the Jura; whilst we find on soils of mica, slate, and granite, in Bavaria, &c., the finest forests of other trees which cannot be produced on the sandy or calcareous soils upon which pines thrive. It is explained by the fact that those trees whose leaves are renewed annually require for their leaves six to ten times more alkalies than the fir-tree or pine; and hence, when they are placed in soils in which alkalies are contained in very small quantities, they do not attain maturity. When we see such trees growing on a sandy or calcareous soil—the red beech, the service-tree, and the wild cherry, for example, thriving luxuriantly on limestone—we may be assured that alkalies are present in the soil; for they are necessary for their existence. Can we, then, regard it as remarkable that such trees should thrive in America, on those spots on which forests of pine, which have grown and collected alkalies for centuries, have been burnt, and to which lands the alkalies are thus at once restored? or that plants remarkable for the quantity of alkalies contained in their ashes should grow with the greatest luxuriance on the localities of conflagrations? It is thus that wheat will not grow on a soil which has produced wormwood (a plant remarkably abounding in potash, the 'salt of wormwood' of the old chemists); and that wormwood does not thrive where wheat has grown, because they are mutually prejudicial, by appropriating the alkalies of the soil.

It has been sometimes noticed by the farmer that the same luxu-

HAYMAKER: We put it into cocks, because we wish to dry it well without losing any of the juices of the grass. Now, the dews and the rain, where

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riant growth of certain plants is produced on the site of fires in a field, although the ashes produced are carefully removed. This arises, amongst other reasons (even supposing that none of the soluble or insoluble portion of the ashes is allowed to mix with the soil), by the charring effect of the fire upon the organic matters of the soil on which it rested; for all soils contain more or less of these animal and vegetable substances, and their partial combustion produces the same ingredient, such as charcoal, salts of lime, alkalies, &c., as the weeds or other plants burnt on the surface of the land. The amount of organic matter contained in soils is, in fact, much more considerable than is generally understood. Davy found four per cent. in the soil from Sheffield Place, in Sussex, and five per cent. in the finely-divided matters of a turnip-soil from Holkham (*Lec.*, p. 175). And how deeply these animal and vegetable matters are dispersed, is shown by the fact that they are found in even the clays obtained from pits by the makers of pottery ware. It is upon similar chemical principles that Professor Way has recently given an explanation of the origin of fairy-rings, which are caused by the growth and gradual spreading from a centre of certain agarics or toadstools. The ashes of these, and of the grasses which formed the fairy-ring, being examined, were found to contain per cent. (*Jour. R. A. S.*, vol. vii., p. 550),

	Agarics.	Grasses.
Silica	1.09	16.10
Lime	1.35	10.47
Magnesia	2.20	2.49
Peroxide of iron	—	2.93
Phosphoric acid	29.42	6.54
Sulphuric acid	1.93	5.40
Carbonic acid	3.80	12.47
Potash	55.10	35.23
Soda	3.32	—
Common salt	0.41	5.79

"On the foregoing analysis," observes Mr. Way, "I think we may clearly explain the whole growth of the fairy-ring. A fungus is developed on a single spot of ground, sheds its seed, and dies. On the spot where it grew it leaves a valuable manuring of phosphoric acid and alkalies, some magnesia, and a little sulphate of lime. Another fungus might undoubtedly grow on the same spot again; but upon the death of the first, the ground becomes occupied by a vigorous growth of grass, rising like a phœnix *on the ashes of its* predecessor. An experiment was made of *spreading some fungi* on the grass of the pasture where the rings *occur. The letters,* in the form of which the fungi were arranged, the grass is spread thinly over the surface, or is left in the swarth, washes out the best part of the hay. If we left it till heavy rain had well washed the drying grass, it would be of little value; all its sweetness would be gone, and it would not be of more use for our own horses than so much pea straw.

CHARLES: But why not cart it, then, as soon as it is ready to put into cocks?

HAYMAKER: No, sir, that would not do. There is a certain portion of the juices of the grass which we wish to dry *in* the grass, and not to have washed out. Now, when we have tolerably dried the grass, we put it into cocks, and there a slight fermentation or heating commences; and the steam from the hay which is thus formed the wind carries away. Then, after a day or two, we take advantage of the first good haymaking day, and spread the hay in the cocks out in the sun and wind before we cart it. By this means, too, the hay is more gradually made. We do not, by this plan, dry only the *outside* of the blades of grass, but we get out the water from the inside; and, when this moisture is pretty well out, we carry it to the haystack, without any fear of our haystack heating too much.

MARY: Why do you allow the hay to heat? Can you not prevent it?

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were clearly visible a month afterwards. Such researches as these, although they may be correctly regarded as mere preliminary steps in our attainment of knowledge, are still advances in the right direction to the examination of the abounding phenomena which attend the farmer in every field and in every path. They all tend to lead him on to higher and holier ground—to elevations whence he can discern the arrangements and wisdom of God, as clearly and as gratefully in the white clover springing up by the road-side after, perhaps, a gypsy's fire, or in the dark green herbage of a *fairy-ring*, as in the luxuriant growth of the corn, whose seeds are *sown by man* and fertilized by his labours.

Haymaker: We do not wish to prevent it. We could easily do that, if we thought proper, by drying the grass till it was as dry as straw. But then it would certainly get washed by the rains; and then it would have neither goodness, taste, nor smell in it.

Mary: What do you mean by saying that the hay would not have any goodness in it?

Haymaker: Why, it would not keep the live stock of the farm in such good heart; that is, it would not have so much nourishment in it. If I take some hay and soak it in water, the water becomes of a brown colour; it makes what we sometimes call hay tea, and contains a certain quantity of goodness or nourishment in it. Now, what the water gains the hay loses; and that is exactly the case when we let the rain wash and spoil the cut grass while we are making hay.

Charles: I remember last year your master, farmer Williams, saying he had been salting his hay. Why did he do that?

Haymaker: It is a good plan of my master's. It is adopted after a wet haymaking time, when the hay has been washed by the rain, in order to give it a flavour or relish for our live stock. They are so fond of salt that they will prefer badly harvested hay, which has salt in it, to the best hay without salt. We put salt, in all seasons, into the hay, from Hungerdown Mead, and one or two others, where the grass is always coarse, and contains a great abundance of the woolly soft grass. This we find the cattle do not much like at any time, whether as grass or as hay.

Mary: Is it not very strange that cows and *horses and sheep* should like *salt* in their hay?

Haymaker: Yes, miss; it does seem strange that they should be so fond of salt. But it's *certain* they *are* fond of it; for we keep a lump of rock salt in the cart horses' mangers, and they gradually lick it all away. We put some salt into the troughs for the sheep, and they eat it very regularly. In fact, we can't hinder them from following the salt, put it where we will. Three years ago master sowed some salt, by way of an experiment, on a patch of ground on the home field; and, sure enough, the sheep and horses found this patch out directly; and they bite the grass so bare on it that you may see where this square patch is eaten out of the middle of the field a quarter of a mile off. I rather fancy our horses know more about the taste of the grass than we think they do; for when we spread some gypsum powder over a patch of red clover, in our ten-acre field last year, I saw that our cart horses always kept on this patch as long as there was a blade of clover left. I don't know why this is, but I do know that I saw that with my own eyes.

CHARLES: These facts are most extraordinary and interesting. The instinct which God has given these animals is most wonderful. Papa pointed out to us an instance of that the other day, you know, Mary, when the gardener was wheeling the rubbish from our garden to the heap under the hedge, on the common. You remember that he bid us mark how carefully the old grey horse there, belonging to the sand carter, picked out the few grass weeds from the heap, and how readily and entirely he avoided eating the laburnum shoots. He munched up the blades of grass, but he did not touch the leaves of the daffodils, or any of the flowers. *And he did* not seem to have any difficulty in the *matter—not* even when we tried him with the new

American plant, which the old horse had certainly never seen before; for he did not stop to taste, or even to smell at it, for a moment. It is quite certain that he knew, somehow or other, as soon as he saw it, that it would not suit him.

MARY: It is very curious, and yet God gives every animal this instinct; for we know that, if they had not that power, they would soon poison themselves. And then you remember the still more wonderful instinct in the cabbage butterfly, that papa read us the account of. The butterfly cannot eat cabbage; it lives upon the sweets and the aroma of flowers; and yet, by some marvellous instinct, it lays its eggs upon cabbages, because these eggs soon turn to caterpillars; and these caterpillars would die of starvation, if placed upon the sweetest flower. But this danger, in some way or other, the butterfly seems to have foreseen and provided against, by depositing her eggs on the very leaves which were to form the future support of her young. Well may we say—"Great and most wonderful are thy works, O Lord; in wisdom hast thou made them all."

MARY, CHARLES, AND THE FARMER.

DOMESTIC ANIMALS.

CHARLES: Everybody says, sir, your cattle and horses always look so well, and are so quiet. How is it that you keep them so nicely?

FARMER WILLIAMS: It is because they are kept so *quiet* that one chief cause of their good looks is owing. I never suffer my carter to overload or beat my horses, and I see that they are fed regularly and quietly. I will allow of no noise or rough usage, either in the field or in the yard. In consequence, my cows and sheep and horses are seldom frightened or rendered feverish, and are sure to thrive the better for it. Then, again, I see that they are fed *regularly;* for, if they are not so fed, they never do so well. Then I keep them as clean and as warm as possible. Even my pigs thrive the best for being kept very clean and moderately warm. We have, many of us farmers, noticed that pigs always do the best when their styes and yards open towards the south, and are protected from the cold easterly and northerly winds. As for cruelty to animals, I make it an invariable rule to discharge every person from my farm who is guilty, in a single instance, of such wanton wickedness.

MARY: I am quite sure we get from your farm, sir, the nicest and sweetest milk; and dear mamma says she is always sure of some from your dairy maid.

FARMER WILLIAMS: That is because I shut my cows up, in the heat of summer, during the hottest part of the day, in a cool dark shed, out of the way of the gad-flies, while my neighbour's cows are running around the fields, in the greatest heat and terror, trying to brush themselves against the hedgerows, and in a fevered state; so that we need hardly be surprised that their milk is very short in quantity, and of an inferior quality. And then I take care to keep them in a dry, warm yard in winter. Those are my secrets, miss; and it is by doing, even by my cows, as I would be done by, that I not only exercise to the fullest extent one golden rule of our Bible, but I have the further comfort of reaping the rewards of this gentle and careful treatment of the animals, in their improved value and good looks—

in their freedom from vicious tempers, and in the comfortable feeling that I am thus devoutly and reverently endeavouring to do my duty to the noble dumb animals that God has, in his merciful kindness, entrusted to my care.

MARY, CHARLES, AND FARMER WILLIAMS.

FROST AND SNOW.

MARY: When you said, sir, the other day to my papa, that this deep snow and hard frost would do your farm good, what ought we to understand by that?

FARMER WILLIAMS: The frost does good to my land in several ways. It kills a good many grubs, slugs, insects, and small birds, which feed upon my corn. It is the kind of winter weather in which my cattle and sheep always thrive best. Wet, cold weather does not suit them; even my very youngest lambs bear a dry frost much better than a cold, foggy, or rainy day.

CHARLES: Then it does good, sir, by its effects to your living things as well as to the land?

FARMER WILLIAMS: Yes, it does good to my stock, and to my land too. Some of my fields have a heavy clay soil, which the frost very materially aids me to render more fit for sowing with corn. These kind of soils break up before the plough, in great tenacious clods, which, when they are dry, will not crush with the roller or break with the harrows. And then when the rain has well soaked them, they are so very adhesive, that the roller can only crush them into flat stiff cakes, and the soil then adheres both to the roller and the harrow so *very* much as to render all our efforts nearly useless;

so we wait for the frost: this freezes and expands the water in the clay; and then when the thaw comes, the adhesiveness of the particles of the soil being very much reduced, the clods either crumble down of themselves, or are readily brought to a sufficiently mouldy state by the use of a light harrow.

MARY: But, sir, does not frost injure your crops? My geraniums were all killed last week by the frost.

FARMER WILLIAMS: No, far from it. I think it does them good. I fancy that after a hard winter, my wheat and the trees in my orchard all come on much faster as soon as the spring arrives, than when we have had a mild and moist winter. If they have been long buried in frost and snow, they seem to me to become, if I may apply the term to a plant, *impatient* of warmth. They seem to jump out into leaf like the crocuses and snowdrops, which always appear to me as if they were afraid of losing the first gleams of sunshine in the year.

MARY: Well, sir, but I think there are animals that surely the frost is not good for, such as fish, for the carp in our neighbour's fish ponds were all killed last year? I heard him say myself that the frost had killed them all.

FARMER WILLIAMS: That was certainly an error. He ascribed to one cause what more correctly belonged to another. It was not the cold which killed the fish, since fish can bear a very low or a very high temperature. In winter, too, fish retire into deeper water, and in deep water the temperature never sinks below a certain degree.*

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* This remarkable exception in the case of water to the general law is thus described by Professor Brande:—"In general, all liquids expand and contract in proportion as they are heated and cooled, but to this law there is a remarkable and anomalous excep-

MARY: Then, if the cold did not kill the fish, why did they all die?

FARMER WILLIAMS: They all died for want for air. The frost was very intense; the surface of the pond was completely encrusted to the depth of two or three inches with ice. This prevented the poor fish from getting a breath of air; and, although it is not generally known, yet fish require air as well as other animals. When, therefore, the pond was frozen, and as soon as they had exhausted all the

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tion in regard to water. When a large thermometer tube is filled with water of the temperature of 60°, and placed in a cold situation, or in a freezing mixture of ice and salt, the water goes on shrinking in the tube, till it has attained the temperature of about 40°; and then instead of continuing to contract till it freezes (as is the case with other liquids), it slowly *expands* and actually rises in the tube till it congeals. In this case, the expansion above 40° and below 40° seems to be equal, so that water will be of the same bulk at 48° and at 32° (the freezing point of water). This anomalous expansion of water by cold is productive of some important consequences, considered as a natural operation; for if water, like other fluids, went on increasing in density till it froze, the consequence would be, that large bodies of water, instead of being only superficially frozen in winter, would be converted throughout into solid masses of ice. Let us take a fresh-water lake as an example. The earth being in winter warmer than the air, the heat is withdrawn from the surface of the water by the cold breezes that blow over it, and the whole body of water has its temperature lowered to 40°, *which is the point of its greatest density,* and a temperature perfectly congenial to fish, and most other aquatic animals. The cold now continues to operate upon the surface of the water, but instead of diminishing its bulk, and therefore rendering it *heavier* than the warmer water beneath, it expands it and renders it *lighter,* so that under these circumstances a stratum of ice-cold water (at 32°) will be found lying upon the mass of warmer water beneath it (at 40°). The influence of the cold continuing, the surface of the lake will soon freeze, but the water immediately below the superficial covering of ice will be found comparatively warm; and as water is almost a non-conductor of heat, it will be a long time before the ice attains any thickness, and the whole body of water, if of any depth, can never freeze throughout. Indeed, it will be obvious that the retardation of freezing will be proportional to the depth of water which has to be cooled, and hence some very deep basins or lakes are scarcely ever even covered with ice."

air in the water under the ice, they were all suffocated for want of it. If you place fish in a vessel of cold water that has been previously boiled, they all die, and for the same reason, because boiled water is free from air.

Mary: That is very curious. I have often wondered why boiled water should be so tasteless. Is the want of air in it the cause?

Farmer Williams: It is. We can satisfy ourselves that this is the true reason, by merely allowing the boiled water to remain in an open vessel for a few days; in that time the water gradually absorbs one or two of the gases of the atmosphere, it loses its insipidity, and becomes pleasant to the taste, and then fish will live in it again.

Charles: But how did it happen that the fish in our pond did not die in the frost as well as those in Mr. Leigh's pond?

Farmer Williams: Because I know that your gardener took care to give the fish air, by breaking a hole in the ice and keeping it open all the time that the frost lasted.

Charles: So he did; for I remember telling him he had spoilt my best sliding-place. But I thought he only did it to get water out of the pond.

Farmer Williams: There was another reason why the fish died in Mr. Leigh's pond; it is a stagnant water-full of everything that is unwholesome. The stable-yard is drained into it, and it is full of dead weeds. These matters putrefy; and when they putrefy various gases are emitted, and rise through the water to the surface, where they escape into the air. Now, when the pond is encrusted with ice, these gases are kept in, and are diffused through the water, and are exceedingly noxious to the fish.

Mary: Then I see that fish like good air and cleanliness as much as other animals.

Farmer Williams: There is no doubt of it. To suppose that fish prefer foul water to sweet, is to make a very great mistake as to the habits and tastes of these animals.

THE EFFECTS OF WARMTH.

Charles: You were kind enough to tell us the other day, sir, that the soil of your farm is a very *warm* soil. What did you mean by that?

Farmer Williams: I mean that it is a good mouldy soil, well drained; so that the warm air can well circulate through it. And also it is a warm soil, because the fields are pretty far down in the valley, sloping to the south and south-west, and well sheltered by the hills from the cold northern and easterly winds.

Mary: But does it, sir, make any difference to your land, its being low down in the valley?

Farmer Williams: Certainly it does. The higher I ascend up the hill, the colder I find the air becomes. You will notice the effect of this in those whose farms are further up our range of hills. I can grow on my farm all the corn crops which delight in a temperate climate. I can produce from my warm soils wheat, and barley, and oats, even to the tops of my highest lands. But farmer Yates, whose farm is above mine, cannot grow barley profitably; for barley needs a warm climate. Then, again, there are certain of his very highest fields on which the wheat never does well; and then you know that, at the very top of the mountain, and on it s northern slopes, there is a little farmer who *never tries to grow* anything but oats, and these do not always do well; and yet oats will grow in a climate, and at an elevation, where no farmer can profitably grow either wheat or barley.

CHARLES: I remember now that we always find it very cold up at his little farm. The most elevated lands are always the coldest; for I was reading the other day that the tops of some of the highest mountains, even in the hottest portions of the globe, are always covered with snow.

MARY: And if this is the case, rising up a mountain is the same thing, as far as crops are concerned, as if we travel from the hot countries near the equator to the cold northern parts of the world.

FARMER WILLIAMS: To be sure it is. If you travel up our mountains, you will see, as you proceed, exactly the crops cultivated as you do in progressing from the warm south coast of England towards the cold northern extremity of the island. After leaving the barley and wheat lands of the south, you will find the proportion of oats and barley which are cultivated gradually decrease as you get towards Scotland; and as you still keep on towards the north, the wheat and barley entirely give place to the oat and the rye, since these can be cultivated far beyond the districts where barley and wheat cease to produce profitable crops.*

MARY: But I heard you say the other day that you were sure the climate of our parish had become warmer than it was when you were a boy. How do you account for this, sir?

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* This progressive course of vegetation on mountains has not escaped the notice of the naturalist. At the foot of Mount Ararat, Tournefort observed the plants which grow in America; a little higher, those of Italy and France; and above, those of Sweden; and upon the summits, those of Lapland. Observations of the same kind have been subsequently made on Mount Caucasus, the Alps, Pyrenees, and other mountains of the old continent, and the much less elevated mountains of Britain. Linnæus, in his own way, has summed up these observations in an axiom. "The different kinds of plants," he tells us, "show by their stations the perpendicular height of the earth."

FARMER WILLIAMS: I did say so; and I am certain I am correct in my conclusion. We have less fogs, earlier springs, and winters less severe; and I am sure that the improved cultivation of our land has done all this. We used to have our best lands full of woods, and our woods and other lands were full of stagnant water. These, of course, kept, as we used to say, the land cold; the sun never seemed to warm it. It raised a great deal of water in vapour, it is true; but that unwholesome vapour made the air full of mists. Then came the age of improvement. We all, when I was a boy, laughed at the idea of science being useful in farming; but we don't do so now. About the time I took this farm, the land was first drained deeply and well, and then the woods in the valleys soon gave place to cornfields; the land water was got well out of the land; and what is very strange, but very true, the fogs which were always hanging over these old woods, at almost all times of the year, have never been much there since. And then our landlords took to planting great belts of larch and other trees, on the hill tops; and this has not only sheltered our sheep, but it has certainly made even our valleys warmer. We have less violent winds; the snow does not lie so long on the hills.

MARY: But then, sir, if the valley has become warmer in your remembrance, has not that made more corn grow?

FARMER WILLIAMS: Yes, that it has very certainly. We grow not only more corn since we drained the land, but we grow wheat and barley higher up the sides of the mountain than we did in my father's time; and we can never, I think, be too thankful to God that it is so; for if he did not bestow his blessing on our efforts to improve the land, we should, as our beloved country increases in population, be in some danger of having more mouths than food.

MARY, CHARLES, AND THE LABOURER.

DRAINING.

MARY: How very deep you are digging the trench, Neighbour Flowers. You are surely not going to divide this nice field into smaller fields? You do not mean this, I hope, for a ditch?

LABOURER: No, miss; we are digging this trench for a drain, four feet deep, to lay in some draining pipes, to carry off the land water.

CHARLES: But why does Mr. Williams, your master, go to the expense of laying them so deep in the ground? I remember, when we drained our pasture some years since, we only placed them about the length of my arm under the turf?

LABOURER: That, sir, is a very poor way, and is the most expensive after all; for you are obliged, when you place them so near the top of the ground, to put the rows of draining pipes much nearer together; and then the roots of the crops are sure to get down into them, and so stop them up.

CHARLES: I remember, as you say, that my papa was obliged to have some of the draining pipes relaid last year, because the roots of the elm had got in, and quite filled them up.

LABOURER: That was very likely to be the case. We can only get out of the reach of the roots by going to a good depth; and then the deeper we lay our drains, the more completely do we remove the land water—I mean the water which is in the land *under* the top soil.

MARY: But has not Mr. Williams spent a great deal of time and money about this field?

LABOURER: Yes, miss, that is true; but it has paid him well at last. When we first began upon this field, it was a mere bog, full of quicksands; and when our neighbours heard that our master had taken a long lease of it, and was going to improve it so much as to enable him to grow corn, they all said he was going to take a bad job in hand: "it was of no use to try."

MARY: Then why did Mr. Williams persevere?

LABOURER: Because our master always says that every thing may be done by a good heart, and that the great difficulty in every thing we desire to accomplish is to have the courage to set about it in earnest, and resolve to do it.

CHARLES: But how did he manage to make it grow such crops as it has done lately?

LABOURER: We began by draining off all the stagnant water, for that is the first thing to be done in improving land; when we had drained off the water, we found a dreary prospect before us, sure enough—a soil that had nothing but peat and sand in it, full of rushes and plants which grow only in water. But when the water was gone these soon died away. Then we levelled the land; then we gave it a good dressing with clay, for we had no marl handy; if we had, we should have used the marl; so we did the best we could with the clay; then we gave it a dressing with lime: these soon mixed with the soil, and we first got a crop of potatoes, then we got some oats, and so we have gone on from time to time giving it a little more clay. This has made the peat soil more and more firm, and so at last we got it, by our tillage, firm enough to grow wheat. And so you see master was right at last, when he did not listen to those who said to him "It is of no use to try."

Mary: Thank you, Flowers, for your account of the improvement of the field. It is a story that we may remember with advantage on many other occasions.

Charles: I think, Mary, that story of Flowers, on the improvement of a barren field, well applies to us, and to those of our school-fellows, who are sometimes too indolent to attempt any useful learning, for fear that they shall not be able to overcome the task given them. They view the prospect before them as some of the farmers did that field, and they shrink from all attempts to conquer the difficulty, and leave the honour and the profit to those who, without any more ability than themselves, have only more courage. I feel convinced that it is very often a mere mixture of idleness and irresolution which prompts so many boys and girls to say "It is of no use to try."

MARY, CHARLES, AND THE PLOUGHMAN.

SOWING AND REAPING.

Charles: I see you are ploughing up this clover field, Neighbour Flowers. What are you doing that for?

Ploughman: I am ploughing up the clover, in order that we may dibble wheat upon it.

Mary: But you seem to make the ground you have ploughed all lie in smooth solid slices of earth, as it were. Would it not be better if you broke the soil more like the mould of our garden?

PLOUGHMAN: No, miss, that would make it less fit for a crop of wheat. Wheat likes a good solid soil to root in; if I made the soil more loose, the young plants of wheat in winter would not do so well.

CHARLES: Why so?

PLOUGHMAN: Because, besides other reasons, the frost would injure it. The frost lifts it by swelling up the land, and then the plants become what we call root fallen; that is, the roots have not strength to support the plant.

MARY: Are there any other crops which are fond of a hard soil?

PLOUGHMAN: Yes. There is the *trifolium incarnatum*, for instance, that does best in most soils, when the ground is not ploughed at all, but the seeds merely covered with the harrow on the surface of the unploughed ground.

CHARLES: But some of your fields have a light soil, which always plough up loosely; how do you manage then?

PLOUGHMAN: When we have drilled the wheat, we roll it with as heavy rollers as we can, and in some cases we fold our flock of sheep on it.

MARY: What do you mean by folding the sheep on it?

PLOUGHMAN: We confine the sheep in small square portions of the field between hurdles, and feed the sheep there. The sheep, by constantly moving about, tread the soil down firm. We feed them there, and they thus bring the soil into a state more suitable for the growth of wheat.

Charles: In coming through the next field, we saw them drilling wheat. One of their sacks of seed wheat was beside the pathway; and we noticed that the wheat was covered over with a white powder. What was that for?

Ploughman: We wet the wheat seed with salt and water, and then dry it sufficiently for the drill by mixing it with a quantity of slaked lime. We have done this ever since I can remember. It is to prevent the disease we call the smut. If we did not do this, we should find at harvest time a good many ears in the corn-field, full of a fine black powder, instead of flour.

Mary; I see, then, you do not forget harvest time, even when you are ploughing?

Ploughman: Oh no, miss; that would never do. The Bible, you know, tells us that as we sow so shall we reap. And the more I see about the farm —the more master explains to me the why and the wherefore, the more I see how true that text is in farming—nay, in everything else.

Mary: I do not understand farming; but the longer I talk to you, and to your master, Mr. Williams, the more I see that there is more skill required in its pursuit than I once thought it needed.

Ploughman: Yes, miss, that is very certain. It is now many years since I began to be a ploughboy. We then had only a great heavy plough, made by our old blacksmith's father. It was a poor tool, and we were obliged to have four great heavy horses to plough with. They moved very slow, and we rarely ploughed more than an acre a day. But now we have better and lighter ploughs, lighter and quicker horses. We plough oftener, and so the land is never so hard to plough.

Charles: Do you do anything else to the seed wheat before you sow it?

Ploughman: I believe not. We are careful to cleanse it from the seeds of weeds, and we change the seed as often as we can.

Charles: Why do you change the wheat?

Ploughman: We find that, by changing the seed as often as we can, it grows stronger and ripens quicker. We like, however, to get the seed, if we can, which is gathered from a colder soil than our own.

Charles: I hardly see the reason for that.

Ploughman: I cannot tell you *why* it is, but it is certain that it is so; just as we feel sure that if we have had our wheat-crops exposed to the cold of a severe winter, they will begin to grow faster as soon as the spring comes, than if they have had a mild winter with but little severe weather.

Mary: That was just the case with some of the young vines which grew for two years in pots in our neighbour's hothouse. When some of these were turned out and set, last autumn, in an open border, they did not begin to put out their leaves till some time after the other young vines which had always been growing out-of-doors; and the gardener said that this was because the vines from the stove were made *tender* by the warmth, and those growing out-of-doors *hardy* by the cold; but then he said, if he placed one of these hardy young vines in his stove, that this put out its leaves much quicker than those vines which had always been used to the warmth, and was therefore not so susceptible of the influence of heat.

Charles: Yes, I remember that; and it confirms what our neighbour Flower says; and, indeed, all I hear, everything I can remember, assures me more and more that the saying is very true which tells us that "as we sow, so shall we reap."

MARY, CHARLES, AND THEIR FATHER.

WORK AND WAGES.

MARY: How very sweet the earth smells that this good labourer is forking over! But why does he not use a spade instead of a fork?

Mr. ASHWORTH: He uses a fork because it is much easier to force its sharp points into the hard ground than the broad end of a spade; and besides, the soil is, you see, of an adhesive kind, containing a great deal of clay; and as it is desirable, in breaking up this soil, to cause it to crumble to pieces as much as possible, a fork attains this object better than a spade, for a spade raises it only in large spits or lumps.

MARY: But, as this is a large field, why does not his master, Mr. Williams, plough and harrow it, instead of setting his men to fork it over?

Mr. ASHWORTH: This is a time of the year when labourers are to be had in abundance, and the price of labour is less than in other seasons of the year; and Mr. Williams is one of those many kind farmers who care for the poor. Besides, it is a question if the forking over certain descriptions of soil is not more profitable than using the plough.

CHARLES: Why is that, sir?

Mr. ASHWORTH: The use of the fork has, on some soils, peculiar advantages over the plough. In the first place, the fork may be thrust deeper into the soil than a common plough; and its points loosen the lower portion of the soil without raising it to the surface, as the plough or the spade does.

CHARLES: But what harm do the *lower* portions of the soil produce by being brought to the surface?

MR. ASHWORTH: Almost all soils brought from a certain depth are for a time barren. You may see this in a chalk-pit, or a sand or clay-pit. The earth remains bare for a season or two.

MARY: And I remember that the earth which was raised when our well was dug would not grow anything upon it for a year or two; and the new gravel on our walks does not need weeding for a long time.

CHARLES: But then, sir, what causes weeds and other plants to grow after a year or two, although at first barren?

MR. ASHWORTH: By the action of the air and the rain, a certain portion of the new earth is so altered in composition, or decomposed, as the chemists say, that it gradually becomes fitted to support vegetation. It gets mixed with certain vegetable and animal substances, and thus a mould or fertile soil is at length formed.

CHARLES: But why, then, not bring it at once to the surface by the spade or the plough?

MR. ASHWORTH: That would not do; for if Mr. Williams adopted this plan, he would lose almost all the produce of his field for a considerable period. He therefore, by using the fork, deepens the soil, and at the same time keeps the already-productive soil on the surface.

CHARLES: But then the under-soil remains barren and useless.

MR. ASHWORTH: No, it does not; for by being *loosened,* the air and the rain penetrate to it, even through the surface-soil; and thus it is gradually decomposed, and formed into a productive soil—more slowly, it is true, than if it was raised at *first* to the surface, but still within a reasonable period. And then, when it is thus rendered useful, Mr. Williams will, after a proper time has elapsed, perhaps two or three years, raise it at once to the surface, and mix it with the rest of the soil,

MARY: But what benefit will that produce?

Mr. ASHWORTH: It will make the whole soil more productive, by increasing its depth. The deeper the soil, the deeper the roots of the farmer's crops can penetrate in search of the moisture and other food which they derive from the soil. It enables them to withstand long-continued dry weather without injury.

MARY: I remember now that the grass which grows on our lawn, over the place where the deep trench was cut to lay in a water-pipe, is always greener in summer than the rest of the turf.

Mr. ASHWORTH: Exactly so; and this is one proof of the good effects of merely deeply *disturbing* or deepening the soil; for you may remember that when the pipe was laid in that drain, the same earth was returned into the trench, and everything replaced as before.

MARY: Then this is an instance of what Mr. Williams said the other day—that he found no means so certain of improving his land as by the application of more labour to it.

Mr. ASHWORTH: It is; and this truth ought to make us feel more and more the goodness of God in thus encouraging and rewarding the owners of land who employ the poor labourers. And it is the labourers who form the true riches of a country, after all.

MARY: But the labourers must be paid, papa, or they would not work.

Mr. ASHWORTH: Certainly not; and we must not forget that it is the labour either of them or of former labourers which enables us to pay them. When we give them on Friday night the amount of their wages, we pay them in money which was raised from the silver mines of distant lands by other labourers. We procured that silver in exchange for various manufactured goods, and these fabrics were the produce of other labourers' hands or heads. It is labour which made everything we enjoy, and it is by labour we pay for it; and if we do not all work for our daily bread, it is merely because the fruit of the labour of other, perhaps former generations of labourers, has been stored up and bequeathed to us by their former owners.

MARY: It seems indeed so. I cannot think at present of a single thing of any value that is not the produce of labour, or capable of being improved by labour.

MR. ASHWORTH: It is certainly so. We all have our own property, or capital, as the merchants call it. The rich have a store laid up by the labour of a former period; the poor have a spring, as it were, of daily renewed labour, which is equally valuable to them. This they exchange with us for money or other things, to enable them to feed and clothe themselves. It is their all—their only property or capital; and, as such, how careful ought we to be, on all occasions, to do nothing which shall diminish their little endowments, by either keeping them unnecessarily long out of work, or by making them wait long for their wages, or by refusing to give them a fair exchange for their only merchandize!

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